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NUMBER I.

ERRATA.

P. 73, l. 6 fr. bot. for *hypochlorate* read *hypochlorite ;* l. 4 fr. bot. for *phosphorus* read *phosphorous*.—P. 75, l. 15, insert comma after *fluoride*, and substitute comma for semicolon after *nitrate*.—P. 93, l. 10, for *presenting* read *prosecuting*.—P. 102, l. 24, for *bank* read *branch*.—P. 292, line 13, after *snatched out* insert *of*.—P. 295, l. 14, for *front* read *forest ;* l. 18, for *as* read *and*.—P. 296, l. 5, for *p*. 12 read 308. —P. 298, l. 21, for *rain* 8 2-3 *in*. read .83 *inch*.—P. 333, l. 4 fr. bot. for *turning* read *twining*.—P. 334, l. 10, for *is* read *inhabits*.—P. 336, l. 5, dele *campanulate*.

Vol. XLII, p. 140, l. 10 fr. bot. for *same* read *successive*.—P. 205, l. 12 fr. bot. for *five* read *four*.

THE

AMERICAN

JOURNAL OF SCIENCE, &c.

Art. I.—*Geological and Statistical Notice of the Coal Mines in the vicinity of Richmond, Va.;* by A. S. Wooldridge, President of the Mid Lothian Mining Company.

TO THE EDITORS.

Gentlemen—I have been delayed in replying to your letter of May last, hoping to receive from the respective owners of the coal mines, statistical statements of their mining operations, that I might transmit you more accurate and full information, than I can hope to furnish without such aid; but as I have failed in securing such assistance, I will submit such a statement, imperfect as it must be, as my knowledge and information enable me to furnish.

The coal-field of this vicinity lies about thirteen miles west of Richmond; is known to extend from about fifteen miles north of James river, south beyond the Appomatox river; is said to be some fifty miles in length, and in breadth about twelve miles—its bearing is some thirteen degrees west of south; it lies upon granite, and is supposed to be in the form of an ellipse; it outcrops to the east and west. The coal lies in six counties—Henrico, Hanover, Goochland, Chesterfield, Powhatan, and Amelia. The mines in Chesterfield county, near the Buckingham road leading from Richmond to Lynchburg, may be said, so far as the north and south points are regarded, to occupy the centre of the field on the eastern outcrop; and it is in this vicinity that the coal appears in its greatest thickness and purity; it varies from fifty

feet to some four or five feet in thickness.* A full and accurate account of the field and the quality of the coals is anticipated from the report of Professor Rogers, to be made to the next legislature of Virginia. It may be well perhaps to remark, that all the explorations and workings in this coal-field, have been confined chiefly to the outcrop or sides of the basin, and that there is nothing yet developed indicating with any degree of certainty how thick or deep the coal will be found imbedded in the centre of the field; but it is believed that enough has been ascertained, to show that so thick, varied, and valuable a deposit of bituminous coal, in the same space, is not to be found any where else.

The first mines discovered in this vicinity, were the old Black Heath pits, Buck & Cunliffe's, Ross & Curry's, Wooldridge's, Railey's, and the Green Hole, and on James river, in Chesterfield county, also, Trabue's and Sallee's pits. These have all been discontinued or worked out; they produced coal of excellent quality for smithing purposes, particularly the Old Black Heath mines.

The mines now in operation are the Maidenhead pits, known as the mines of the Black Heath Company of Colliers, discovered in 1821. There are at these mines several shafts, varying from one hundred and fifty to seven hundred feet deep; during the year before the last, Col. Heth, originally a large shareholder, purchased these mines of this incorporated company, with all their real estate and other property; he bought also Sallee's pits, with a large adjoining tract—intending to combine all these various tracts so as to form a new company, and with that object went out to England. While there, an explosion from inflammable gas occurred in his mines, and destroyed fifty three out of fifty six† persons who were in the pits. He brought out from England suitable men to reclaim his mines, which was done, and with him came agents sent out to examine and report as to the value of this property. He is now in England, closing a sale of the whole of this property, and the agents of the

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* It is probable that this coal-field extends through Virginia into North Carolina.

† One of the persons who survived, was one of three descending the shaft in a basket; they were thrown up in the basket to the full length of the rope running over pulleys at the pit-head frame, that was forty feet above the surface; they were thus thrown probably seventy feet high. The man saved, who remained in the basket, had both thighs fractured.

English company are expected out to put these mines under work—the water being kept out, so that they can be put in working operation at any time. On the Maidenhead tract, are two deep shafts, the one in which the explosion took place, about seven hundred feet in depth, and the other completed during the last year, about six hundred feet deep. The coal from these mines is of good quality, averaging thirty six feet in thickness, and the two shafts can produce two million bushels of coal per annum. On this estate are all the buildings, engines, and other machinery necessary for a large business, with a railroad, the property of the company, leading from the pits to James river, and passing through the tract of land owned by said company, called Sallee's, containing a valuable deposit of iron ore, which it is presumed will shortly be worked extensively and profitably, as the ore is in the midst of the coal mines, intersected by the company's railroad, within a mile of James river, and not more than about twelve miles from Richmond. Explosions occurred several times in the Maidenhead pits, prior to the great explosion. On these occasions several men were killed and burned. At that time the art of ventilating coal mines was imperfectly understood here. Since that period, much greater, if not entire security, exists under the ventilation by Newcastle gas-men.

On the north of these works lie the mines owned by Thompson Blunt, now under a lease to Col. Heth, and best known as the pits of Wills, Brown & Co., of whom Col. Heth purchased the lease; but one shaft and that about four hundred feet deep to the coal, is in operation at these mines; at the bottom of the shaft there are two inclined planes, one worked by mule power and the other by steam. These slopes increase the depth about three hundred feet more; a steam engine is in operation over the pit. A force of about ninety hands is employed, including those at top and bottom and the cartmen; these pits being about two miles from the coal railroad leading from Manchester, which is the shipping point on tide water to most of the mines in the vicinity. The coal, which is about thirty feet thick, is of superior quality for smitheries, and the product about four hundred thousand bushels per annum. Several accidents by explosive gas occurred in these mines during the last year and preceding years, by which some lives were lost, and several men severely burnt. They are now wrought safely, under the management of Newcastle ven-

tilators. These mines were opened about twenty five years ago; during the first year's operation, when the miners were out at their dinner, about one o'clock in the day, and within an hour from the time they ascended, the pit fired and the flames instantly rushed from the shaft to the height of two hundred feet above the surface; whether this was caused by an explosion of gas or otherwise, is uncertain.*

Immediately adjoining these mines on the north, are those called the Gowrie pits, owned by Murchie, Mosely & Brander, and now worked under a lease by George E. Swann. There are two shafts on this property, one about one hundred and sixty feet deep, the other about four hundred and sixty; about eighty thousand bushels of coal will be hoisted from these mines the present year. The coal is about six feet thick; it is suited for grates, and for steam engines. The present prospect is not promising; the shafts seemingly have been sunk on troubles, and a good body of coal is supposed to lie on the dip of the present works. There are employed at these mines forty men, including top and bottom hands and cartmen, and they are about the same distance from the railroad as the last named mines. It is probable that these mines will not be worked the ensuing year.

Next on the northeast, are the old pits of Buck & Cunliffe, mentioned before as having been worked out; and on the northeast of them are the old Black Heath mines in like condition. About two miles north are Sallee's pits, named before as being unwrought, and containing iron ore lying over the coal, and now owned by the English company; in which company Col. Heth retains a royalty upon one half of the minerals owned by it, as well as in the coal property; on the north lie Trabue's old pits, extending to James river, now owned by Thomas M. Burfoot, and under a lease to Stanford, Duval & Co. who have sunk some shallow shafts south of the former workings, from fifty to two hundred and fifty feet deep. There will be raised from these mines during the present year about one hundred and twenty five thousand bushels of coal; they give employment to about fifty men. This coal being raised from near the outcrop, is not very suitable for any thing but domestic fuel. A new shaft is now sinking on

* What other cause can be assigned? It is hardly possible that any felonious attempt could have produced such an effect.—Eds.

this land, and from the great influx of water, a small steam engine has been put up to aid in sinking. On the southeast of these mines, on the lands of Maj. Clarke, some years ago, coal was mined to a small extent.

We return now to the Maidenhead pits, being the point in the working mines where we began, and which lie on both sides of the Buckingham road; Wooldridge's old pits and Railey's, the property of Nicholas Mills, and before mentioned as being unwrought and exhausted, are directly east and adjoining. These mines were not abandoned until the close of the last year, having been for the last half dozen years worked by Mills, Reid & Co. East of these mines are the old Union pits not before named, but worked out, not having been wrought more than some fifteen years after being discovered. South of these, are the exhausted mines owned by Nicholas Mills, and known as Mills Creek pits; which like the Union pits did not last working more than twelve or fifteen years after being discovered. South of these are the old Green Hole pits, before named as one of the oldest pits and exhausted by working. The coal raised from all these old mines was of very good quality. Next and immediately south, lie the Creek Company's mines, discovered about four years ago. They were valued and sold to an incorporated company at $96,000. They have but one shaft in operation, about three hundred and eighty feet deep, worked by a steam engine on the ground, and mule power operating below on an incline.

The present year's product will be, as it has been for the two preceding years, about two hundred and fifty to three hundred thousand bushels of coal, and there are employed here about seventy men at top and bottom. The coal is of good quality, but is difficult to mine in consequence of the field being somewhat troubled. This company own all the necessary machinery, mules, and about thirty men, with a sufficient outfit of houses, two coking ovens, and a branch railroad connecting their mines with the main coal railroad to Manchester. On the south of these works and immediately adjoining, are the Stonehenge pits, now unwrought, owned by the heirs of Martin Railey, deceased. The old shafts at these mines are numerous, and vary in depth from fifty to four hundred feet; it is supposed that the coal extends to the dip of the old works,—new shafts it is supposed will be sunk, and extensive operations may in future be carried on.

The coal from these pits ignites easily and burns freely, being very suitable for grates, locomotives, &c., but unsuitable for smiths' use. There are several seams of these coals; the first from twelve to sixteen feet in thickness, the next twenty eight inches, the third four and a half feet. Other seams are known to exist below these, but have not been worked. These coals were discovered about thirty years ago, by a craw-fish bringing up coals to the surface above his hole. Wooldridge's old pits were discovered by the wheels of the waggons running on the Buckingham road turning up coal in the ruts; and the coal at the old Green Hole pits was said to be discovered by a deer jumping across the creek and throwing up coal on the snow. The time of the discovery is not accurately known.

The Mid Lothian Coal Mining Company's pits lie immediately south of the Maidenhead mines, southwest of Railey's pits, west of the Creek Company's mines, west and south of Stonehenge, and adjoin all these mines. This company procured a charter in 1835, and was organized in 1836. The sinking for coal preceded the organization of the company, and was in anticipation of it. The tracts of land contain four hundred and four and a half acres; upon the northeast corner, being the rise, a shaft had been previously sunk and worked; it is five hundred feet deep. By improvident mining, it crushed the pillars of coal, settled down, and was abandoned in 1836; there not being more than five or six acres worked by the then lessees. These lands, being two tracts, were valued at $300,000, and owned by Wm. Wooldridge's heirs, to wit, Dr. A. L. Wooldridge, Jane A. Elam, Charlotte Wooldridge and myself. The capital was divided into three thousand shares of a hundred dollars each; and one third, being one thousand shares, was sold to some thirty shareholders, in and around Richmond—generally, of the most respectable and wealthy class. The $100,000 cash, the amount thus raised, was given to the company as a capital for sinking, purchasing machinery, for laborers, &c. Four shafts were commenced, nearly in a line on the run of the coal, extending a mile or more. In the autumn of 1839, coal was found in one shaft, at the depth of seven hundred and twenty two feet to the coal, at which time the other three were temporarily suspended, one being six hundred and twenty five feet deep, one three hundred, and the other eighty five feet. These shafts are eleven feet

square, divided into four chambers by timbers, and from the samples of metals sent, you will see that sandstone and slate, in alternate layers, form the covering over the coal. The last shaft was recommenced at the beginning of the present year, and is now down three hundred and fifty feet, and it is expected coal will be reached by the first of next June, at the depth of six hundred feet. The last year about three hundred thousand bushels of coal were hoisted; the present year about six hundred thousand bushels will be raised, and the quantity would have been enlarged had the demand justified the increase. Coal in the working shaft was found, as before stated, at the depth of seven hundred and twenty two and a half feet from the surface—the coal in the shaft was thirty six feet thick, and the sink below the coal is sixteen and a half feet deep, making the whole depth of the shaft seven hundred and seventy five feet. I write now from memory, and may not be critically correct as to a foot. In the journal sent you of the metals,* the specimens and list commence about two hundred and forty feet below the surface. The upper metals in the samples kept, got mixed or deranged, and were thrown away. Any discrepancy (if any) in the journal of metals as kept, with the depth of the shaft as here given, must have been produced by the difficulty of measuring the thickness of the metals on the side of the shaft in sinking. The coal lies at an angle of about thirty five degrees, dipping to the west. The thickness of the coal varies, which is, I presume, produced by the form of the rock upon which it is deposited being uneven; in some places the coal rises to fully fifty feet in thickness. The whole capital was expended in sinking as above described; in procuring a large steam-engine, buildings, mules and mule-power machines, railroads above and under ground, besides some eighteen laborers, and a coal-yard and fixtures. The whole of the lands are supposed to contain coal. The exploring drifts now in progress, extend north and south over a quarter of a mile; the coal on the west being the dip, and on the east being the rise, seems to indicate great regularity,—a drift now going on to the southwest on a slope, shows that the coal is flattening off, it not dipping now more than one in ten feet, and in quality is of the most promising character. It will be seen by

* The miners' name for the rocks and other matters raised with the coal.—Eds.

observing the location of these mines, as stated before, that the lands take in the coal from the eastern outcrop, on the south, so as to reach over on the dip fully a mile, far beyond any explorations westward. The present works and fixtures are capable of producing one million of bushels per annum, and by the aid of a second engine over the same shaft, another million might be produced. The next year, when the sinking shaft shall have reached coal, two millions per annum can be raised, and that quantity doubled by increasing the steam power. Two large steam-engines are now building, and intended to be erected before the close of the season; one over the sinking shaft, and the other in the mines to operate on the incline.

As to the quality of the Mid Lothian coal, I refer to the samples sent you, and the certificates contained in my circular, also forwarded to you; adding this fact, that this coal upon trial has been found to suit a greater variety of purposes than any coal hitherto discovered; and of this you will find ample proof by attentively examining the circular referred to.

The whole effective force at these mines, including the coal-yard hands, and top and bottom hands, is one hundred and fifty men and boys, with some twenty five mules. Most of these mules will be discontinued as soon as the steam-engines are erected. The ventilation of the mines is committed to the management of a Newcastle miner or gas-man of much experience and skill, trained by Mr. Buddle, the distinguished English mining engineer.

The ventilation is kept up by means of brattice work of boards, and aided by a furnace under ground. The atmospheric air is taken down on one side of the shaft, and courses the whole drift, passing out by the furnace in the opposite side of the shaft. On the upcast side the air is received some thirty feet from the bottom of the pit into the shaft, and at the top it is boxed up so as to throw it off fifty feet above the mouth of the shaft. Large quantities of inflammable gas are thrown out from the coal in the mines constantly, and any interruption in the air coursing the mines with regularity, might and would be attended with disastrous consequences from an explosion of the gas. Sir Humphry Davy's lamp is used at the mines, more as a pioneer than otherwise; no mines are considered safe that require to be worked by safety-lamps. They ought to be used only in going through

the mines to see that all is right, before the miners are put to work; or to be used to free the mines in case they are overcharged with gas.

The interior of the mines contains iron railroads of a very simple construction. Iron bars, two inches by half an inch, are inserted edge up into cross pieces of timber, four by two inches, laid at the bottom of the drifts. The iron is admitted into the timber about an inch deep; no wedging is necessary, and the road can be curved at pleasure. Mules are used on these roads below, and thrive and look better there than those above ground.

Impressions of fishes and vegetable remains, such as ferns, bark, and knobs of wood, are often found in the slate lying over coal in this neighborhood. They were particularly numerous at the Union pits, and mines of the Creek Company, which seem to be a distinct formation of coal from the main formation, and many suppose it a deposit at an after date. As no sinking is now going on at either of these mines, I am unable to procure and forward you any samples, as the old ones have been disposed of. I will be upon the watch, and secure for you hereafter any specimens that may be obtained, and worthy of your attention.

The coal basin extends across Chesterfield county to the south to the Appomattox, or perhaps a little beyond the river into Amelia county. No coal, however, has been found of sufficient thickness to justify working, nearer the river than Rowlett's old pits, distant one mile to the north. Between these pits and Hill's old pits, distant five miles still farther to the north, is supposed to be the only part of this section of the basin that will be found valuable from the abundance of its mineral treasure. The coal measures may be traced on the north from these limits to the James river pits, and south a little beyond the Appomattox, but no exploration has yet discovered coal beyond the limits mentioned, in sufficient quantities to be wrought to profit.

Rowlett's pits mentioned above, were some twenty years since leased by a company of gentlemen in Petersburg, wrought for a few years and abandoned; subsequently an incorporated company purchased them, but after a trial of two years gave up further search for coal, having been unsuccessful, though the land is still owned by them. About twenty years ago Hill's pits were first put in operation. These were worked for five or six years, and likewise abandoned. The coal at both of these workings

was of excellent quality, and particularly well adapted to the use of grates and other purposes requiring gas and flame. The exceedingly faulty character of the field at both of these points led no doubt to the abandonment of these workings.

These are the only workings that had been attempted on the south side of this great coal basin, until two years since, when coal was accidentally discovered upon the lands of James H. Cox, next south of Hill's old pits and three fourths of a mile distant. This coal was first discovered on the side of a hill, where it had been uncovered by the washings of heavy rains; for the coal here along the whole line of outcrop reaches within a few feet of the surface, being only covered by a coating of soil, sand, and gravel. Since its discovery, an average of about twenty hands have been engaged in exploring and mining it, and from the explorations already made, the belief is entertained that no part of the basin presents a more regular, uninterrupted, and undisturbed formation than this. The thickness of the seam varies from seven to fifteen feet. The coal is of superior quality, and peculiarly suited to grate purposes, steam engines, the blast furnace, gas works, &c. The accompanying certificate* from Dr. Andrews, shows its richness in volatile matter, and the small quantity of ashes it contains. At present, the operations at these mines cannot be increased to any extent, in consequence of their distance from market, and the want of proper facilities for transportation. The present mode of transportation is to carry it in carts to the river, and thence by boats to Petersburg, at the cost in all of

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* To Charles Berg, Esq.—*Sir:* The specimen of bituminous coal from the Clover Hill coal mine, which you left with me for analysis, belongs to the variety called slate coal. It has a specific gravity of 1.26; principal fracture slaty; cross fracture uneven, brittle, slightly soils the fingers, and is composed of two alternate varieties, one velvet black with a brilliant lustre on the foliated fracture, the other dark grayish black, lustre glimmering. It ignites very freely, and burns with a lively yellow flame; cakes, but swells very little in coking.

One hundred parts contain—

Carbon,	55.
Volatile matter,	38.5
Alumine, Silex, Oxide of iron, } from the ashes,	6.5

It contains also a small portion of sulphur combined with the iron as a sulphuret. The caking quality which it has, will make it a useful fuel for the forge, or for those purposes which require a hollow fire. For the manufacture of gas, I consider it superior to the caking coal of Newcastle, England, or the splint coal of

eight and a half cents. This high cost of transportation forbids, for a time, successful competition with mines enjoying greater facilities. It is designed to remedy this inconvenience by constructing a railroad to the Appomattox, a distance of five miles, or one to intersect with the Richmond and Petersburg road and reach James river some where about Osborne's or Bermuda Hundred. The country through which both of these routes would pass, is admirably adapted to the purpose, being very level and abounding in timber and other railroad materials. Either of these contemplated improvements would place these mines in a state of fair competition with any other mines in Virginia, or perhaps in this country.

These mines have recently been sold by James H. Cox to the Clover Hill Company, who are now working them with a force of twenty laborers. Moody & Johnson have a lease of Anderson's land, next adjoining that of the Clover Hill Company, and employ a force of twelve operatives. These two workings together, last year, produced two hundred thousand bushels of coarse grate coal; the fine coal not being able to bear the cost of transportation, is still remaining at the pits. Whatever has been said about the quantity and quality of the Clover Hill coal, is applicable to Moody & Johnson's coal, as all is taken from the same seam.

The deepest shaft which has yet been sunk is two hundred and fifty feet deep. The measures passed through were principally sandstones and shales. Impressions were frequently met with of ferns and other aquatic vegetables, but no fish or other animal remains.

Scotland, and next best to the cherry coal of Staffordshire. It contains 6 per cent. more volatile matter than the Richmond coal, which is now used at the gas factory in this city. It will answer very well for the grate, and make a cheerful fire.

The following table will show the quantity of volatile matter in each kind of coal mentioned, and also the quantity of ashes.

Cherry coal,	44.75	volatile	matter,	10 per	cent. ashes.
Splint coal,	35.	"	"	9.5 "	"
Richmond coal,	32.	"	"	8.75 "	"
Clover Hill coal,	38.5	"	"	6.5 "	"
Newcastle coal,	22.6	"	"	1.5 "	"

I am, sir, your obedient servant,

GEORGE W. ANDREWS.

Baltimore, Dec. 15, 1840.

The bearing of this part of the field is fifteen degrees to the west of south, and inclines to the west as you proceed to the south, until near the river it is thirty degrees. The same is the case on the western outcrop. This induces the belief that the basin is here rounding off, and that at no great distance to the south of the river, the coal formation entirely disappears. This belief is confirmed by explorations made on that side of the river.

Several mines were worked formerly on James River, on the western outcrop of the coal-field, in Powhatan County, which are now unwrought, principally because the coal both in quality and quantity is not equal to the coal of Chesterfield, and will not bear working in a depressed state of the trade.*

In Goochland County, on the western outcrop, coal of good quality was formerly worked, and known as the Dover pits, owned by Anderson & Moody, and conveyed to the Dover Coal Mining Company. These mines are not now worked, the company having failed. Since the failure of the Dover Company, the mines have reverted to the former owners; and on the east side of the outcrop, on the Goochland and Henrico side of James River, are several mines, some of them now in operation, and some not. The largest operators in that neighborhood, are the Messrs. Crouches & Sneed, the owners of extensive mines in good working condition, employing about one hundred and fifty hands, and raising four hundred thousand bushels of coal the present year. Near these mines, on James river, are those of the Tuckahoe Coal Company. The old mines are out of work, but a shaft is sinking, employing from fifteen to twenty hands, &c.

Near these are Woodward's and Cottrel's Mines, both now unwrought. Northeast of Crouches & Sneed's mines, lie the Edge Hill pits, now worked but not extensively, by Richardson, probably employing some thirty hands, and producing about eighty thousand bushels. On the north part of Crouches & Sneed's property, Townes & Powell are engaged in hoisting coal, but not working more than some twenty hands, producing the present year about one hundred thousand bushels. There may be some other mines in this vicinity not remembered. There is a railroad connecting these mines with the James River canal, down which the coal passes to Richmond. The coal on the north side of

* These mines were worked by three incorporated companies, all having failed.

James River sells for a less price than that on the south side, being considered not as good.*

Some four or five miles north of these mines, lie those called the Deep Run pits, worked by John Barr, who at present employs some forty hands, and raises some two hundred and fifty thousand bushels of coal; he uses steam power. This coal is of fair quality, as is also that from Burton's pits, now mined by Grubs & Co., who will probably raise about the same quantity as Barr, and employ as many hands. The coal from these mines is transported to Richmond by the Fredericksburg and Richmond Railroad Company, a branch of their road having been extended to the pits. The charge for coal on this road is four cents per bushel from the mines to Richmond. The charge for boating coal down the James River canal, including tolls, is about three cents from the mines,—that on coal passing the coal railroad in Chesterfield from the mines, to tide water, is five and a half cents;—for taking it from this road, at its junction with the Petersburg and Richmond railroad, two cents per bushel to Richmond,—to Petersburg four cents, including yardage at either place; and coal going by this road, to either Petersburg or Richmond, is entitled to half a cent per bushel deduction from the main coal road charge. The charge for transporting from the mines on the south side of Chesterfield County to Petersburg, is about eleven cents per bushel, by waggons. It is in contemplation to branch, at some future day, from the main coal road to Warwick, about five miles below the present shipping yards at Manchester, where vessels of large size can load with coal with great facility; a bar just above that place preventing large vessels from going up to Manchester or Richmond. The charge for transporting coal on the principal coal railroad is unusually high, but will soon be reduced. It being the first road of the kind in Virginia, it was deemed prudent to make the transportation high, a dividend of six per cent. per annum, payable semi-annually being authorized in the charter; the surplus raised from the five and a half cents per bushel, being pledged to the refunding of the capital subscribed; this application has been faithfully

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* There is found in connection with the coal at Sallee's and Burfoot's pits in Chesterfield, and on the north side of James river at the mines generally, a substance formerly called dead coal, recently called natural coke, that has lately been used and very much approved as grate fuel.

made, until the whole of the capital, with the exception of some twelve per cent., has been repaid. When that is accomplished, the tolls are to be so reduced as to allow six per cent. upon the then nominal capital only, and to pay the expenses of transportation, at which time the charge for transportation ought to be reduced some two and a half cents per bushel; and if at that time the contemplated branching to Warwick shall take place, and locomotive power be substituted for the present expensive plan of using horse power, then the price of Virginia coal can be so lowered as to make it the interest of all consumers of bituminous coal on our Atlantic border to use it almost exclusively.

Richmond, Sept. 1, 1841.

*Remark by the senior editor.**—The coal of Virginia has been long known throughout the Atlantic states. From the Mid Lothian Coal Mines, we have recently received a series of specimens illustrative of the structure of this coal-field. It is based upon granite, and consists of the usual alternations of sandstones, shales, clays, and coal.

The coal is of an excellent quality; and it appears from printed certificates of many manufacturers, that it is used in very various operations requiring fire, especially in the different manufactures of iron both in light and heavy work, and it is said to have been recently introduced into the manufacture of copper.

Art. II.—*Regarding Human Foot-Prints in Solid Limestone;* by David Dale Owen, M. D., of Indiana, with a plate.

(Communicated for this Journal.)

The occurrence of representations of human feet in solid rock, has lately excited considerable attention, both in this country and in Europe. The intimate connexion of the subject with those great problems, the age of our race and the gradual peopling of our globe with animated beings, invests it with additional interest, in the eyes not only of the scientific explorer but of the general reader also.

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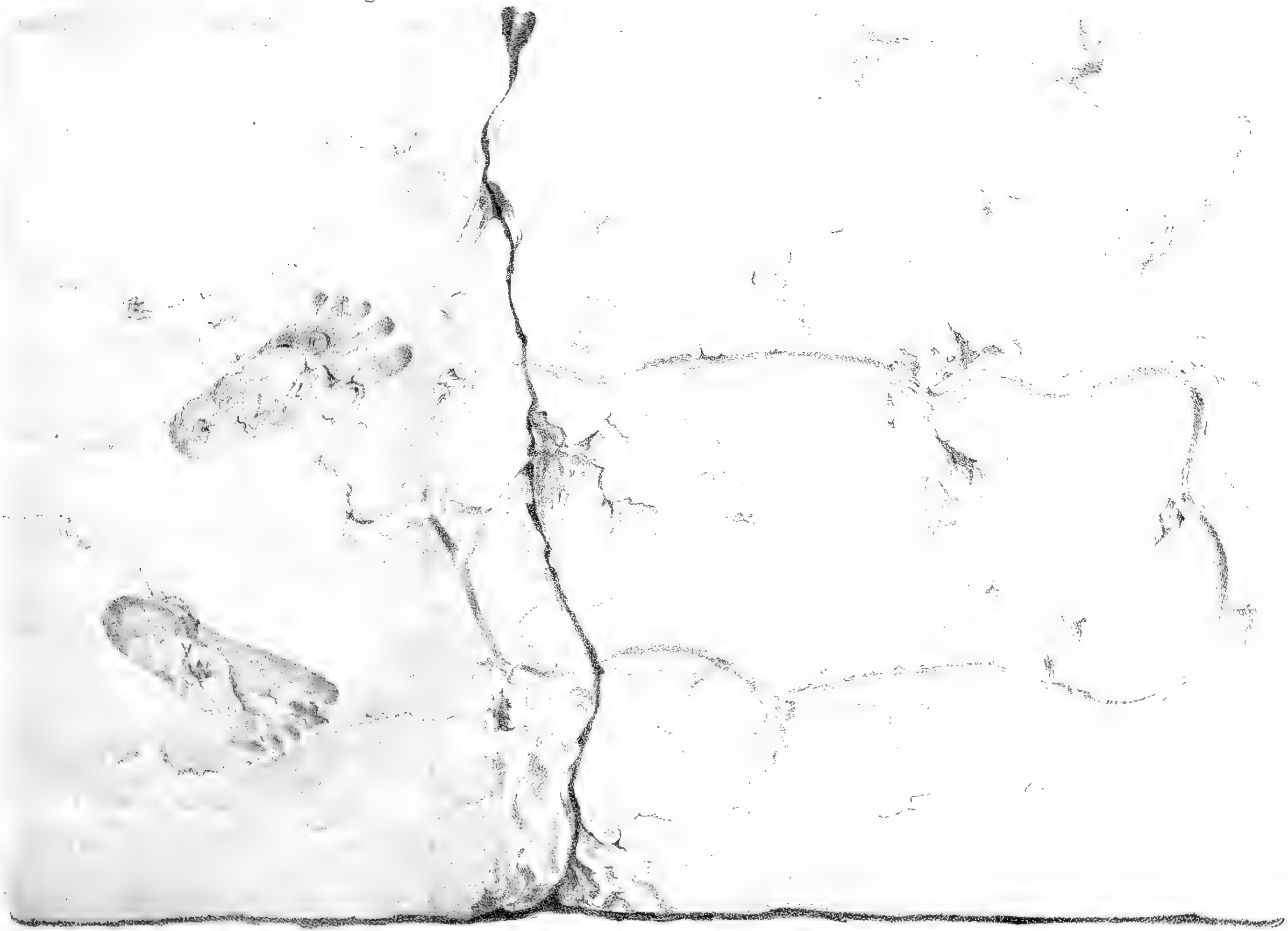
* See Vol. I, p. 125, for an account of these mines, by John Grammer, Jr.



Central portion of the Slab, with foot prints and scroll.

(quarried from the bed of the Mississippi, at St. Louis, in 1819.)

Mr. Schoolcraft, in the year 1822, first called attention, through the columns of this Journal,* to these impressions; the German Professor Leonhard, of Heidelberg, discusses the matter in his popular lectures, now in course of republication in this country by Prof. F. Hall; Dr. Mantell, in his "Wonders of Geology," also speaking of the same foot-prints, says that he has requested Prof. Silliman to ascertain the nature and age of the rock in which they appear; and a correspondent, in a recent number of this Journal, calls for information on the same subject.

These various observations and inquiries, and all others of a similar character which have met my eye, expressly refer to a single specimen; the only one, it would seem, hitherto discovered; namely, a slab of limestone originally found on the western bank of the Mississippi river at St. Louis, quarried for Mr. Frederick Rapp in the year 1819, and by him removed to the German settlement of Harmony in Indiana, where it became a frequent object of visit and examination among curious travellers. There Schoolcraft saw and described it; his article, above referred to, (and from which Mantell tells us he derives his information,) commences thus:

"I send you a drawing of two curious prints of the human foot in limestone rock, observed by me last summer at Harmony on the Wabash, together with a letter of Colonel Benton on the same subject. The slab containing these impressions, was originally quarried on the west bank of the Mississippi river at St. Louis, and belongs to the older flœtz range of limestone, which pervades that country to a very great extent." Leonhard, as a note by his editor reminds us, refers, also, as his sole authority, to the article here quoted, and of course to the specimen in question.

That specimen is now in my possession; and inasmuch as it has thus attracted the observation even of foreign geologists, and has given rise to not a little discussion and contrariety of opinion among scientific men, I feel called on to contribute what information I possess relative to its history and description; more especially as I have recently obtained evidence sufficiently conclusive touching its precise geological character.

The best information I can furnish in regard to the exact spot of its original location, and the circumstances by which it came

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* See Vol. v, p. 223, *et seq.*

into the possession of Mr. Rapp, is to be found in the subjoined extracts from a letter written by the gentleman under whose inspection it was quarried, then a resident of St. Louis, but now of Cincinnati, Mr. Paul Anderson. This letter is dated October 11, 1841, and is in reply to one which I addressed, in the course of last autumn to Mr. Baker, Mr. Rapp's man of business, who was a resident of Harmony at the time of the purchase, and in which I had requested of him to procure for me what information he could on the subject.

Mr. Anderson writing to Mr. Baker, says:

"The letter of Mr. David Dale Owen, of the 20th ult. enclosed in yours of the 8th inst. was duly received by me here.

"Well, sir, as to the limestone slab that Mr. Frederick Rapp obtained of me sometime in 1819 at St. Louis, I will tell you its history. The year after I was located in St. Louis, during the extreme low water of the Mississippi, I was shown the imprint of human feet, that was in the limestone rock on the *very margin* of the river, and which had been only seen by the old inhabitants there very few times; as it was said by them that it was not more than once in the period of ten years or so, that the river fell to its then stage. This rock lay about opposite the centre of the city proper, and seemed to have been polished smooth by the attrition of the water. There was no rock lying on it, as it was the lower ledge of the stratified limestone that reached, by steps, to the bluff of limestone rock that ranged along the foot of the river lots of the city. This bluff of stratified rock was seemingly from ten to twenty feet high, and from twenty to forty yards from the margin of the river at extreme low water mark, all along the city. This bluff has been quarried out and a fine range of three story stone warehouses erected there on the river front. A street, too, of sixty feet wide has been laid off, besides a graduated McAdamized wharf on the outside of that again to low water mark.

"A Mr. John Jones, who claimed a sort of ownership in the rock as being the first discoverer of it *that season*, was employed by me to cut out the slab for Mr. Frederick Rapp, who was then at St. Louis on a business visit. I paid Jones (to the best of my recollection) one hundred and eighty dollars for the slab, and shipped it around to New Harmony to Mr. Rapp. Previous to its being sent away, there was an offer made of five hundred dollars for it by a "virtuoso" from some of the eastern cities;

and in consequence of this high estimate of its value, there were many of the citizens strongly disposed to prevent the slab being sent away from the city.

"I know of no rock along that margin, of a soft and plastic nature, that seemed to be in a process of consolidation; but the opinion was well grounded there at that time, that the imprint of the two human feet had been made on the rock when it was soft alluvium mud.

"I never saw or heard of any imprint of human feet along there or any where else, save on this rock; but I recollect of remarking in many of the steps of the smooth rock along near to the same place from which this slab had been taken out, the numerous imprints of turkey, deer, and buffalo feet.* I often looked to find human imprinted feet, but was unsuccessful."

These extracts fully explain the circumstances under which the slab was originally obtained by Mr. Rapp. When that gentleman, in the year 1824, sold the New Harmony estate to my father, the slab also came into my father's hands, and ultimately into the possession of the late Mr. William Maclure. After his decease, it was presented to me by his executors, and is now preserved in my museum of objects of natural history at New Harmony.

The slab itself is a ponderous mass of solid limestone, weighing upwards of a ton. Although fossils had been observed in the vicinity of its original location, yet until lately no remains had been discovered on the specimen itself. In preparing to remove it, however, from Mr. Maclure's residence to my laboratory, observing a horizontal fissure which extended entirely across the rock, I split off by the aid of wedges a continuous layer, some two or three inches thick, from its inferior surface. This operation, besides materially facilitating its transportation, disclosed, as I had hoped it would, some familiar fossil shells; and I subsequently discovered a good many more by reducing the detached

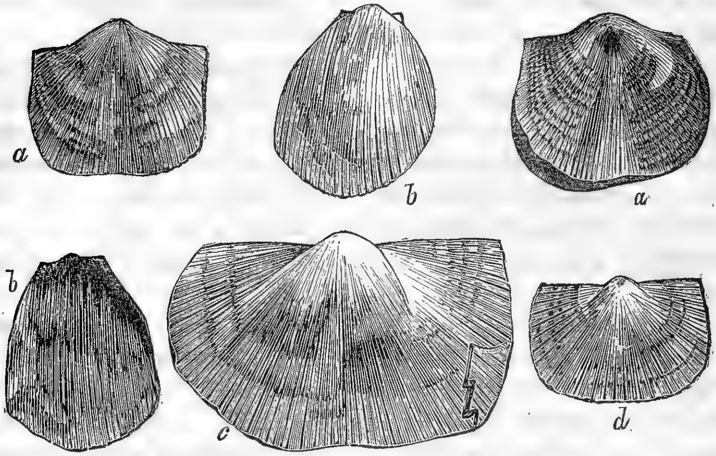
* Those unacquainted with the science of geology, frequently mistake for fossil foot-prints, what are in fact moulds of shells, or merely casual appearances. On the table-mounds in Iowa, a rock contains numerous impressions of a species of *Pentamerus*, which, when partially weather-worn, so closely resembles the print of a cloven foot as to be continually mistaken for it by the uninitiated. Hitchcock, misled by a report regarding fossil footsteps, undertook a journey of several hundred miles—to find nothing but accidental markings on the rock.

portion into small hand specimens. I was thus enabled definitely to determine the age of the rock.

The fossils obtained, proved on examination to be the same species which I had often previously observed at Leavenworth in Indiana, on the Ohio river, and elsewhere, in a rock, the exact geological position of which I had already satisfactorily ascertained. This stratum lies from ten to twenty feet below the lowest members of our true coal measures, and is considered the equivalent of the mountain limestone of Europe.

Four species of Producta, the best preserved among those obtained from the slab, are here represented, (Fig. 1.)

Fig. 1.



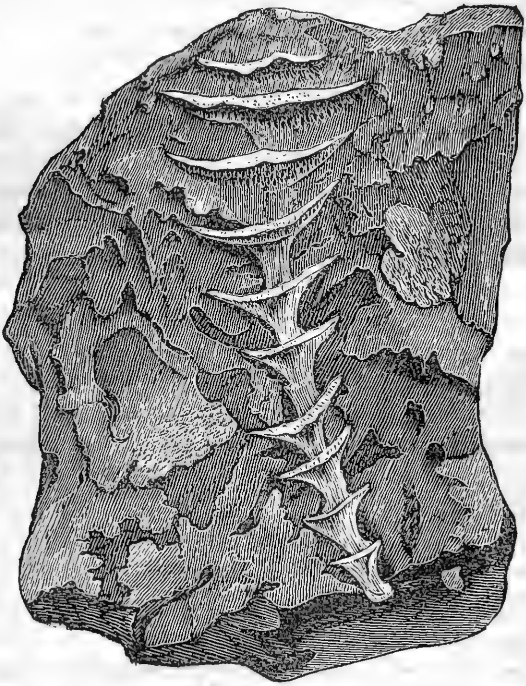
Producta found in the slab.

In the above plate, *a a* are the under and upper valves of a species which I have not seen described; *b b* represent the external and internal view of the under valve of another species, also, I believe, undescribed; nor have I seen *d* described; *c* resembles the *Producta Martini* of *Sow.*, but its under valve is much flatter and less distinctly striated.

I had long since felt assured, from the bearings of our geological formations, that the limestone of which these are characteristic fossils, formed the bed of the Mississippi at St. Louis; but I had not had an opportunity, during extreme low water, of making a thorough examination at that place. The discovery of these Producta confirms in a satisfactory manner my previous views.

There is but one corroborative, though not essential evidence, desirable to add to that already given in proof of the age of this rock. The uppermost bed of the group to which it belongs is a stratum of limestone of a reddish tint, and characterized by a very remarkable fossil coralline, resembling the *Retepora* of *Lin.*, but verticillated spirally like a continuous screw; described by *Lesueur* under the appropriate name of *Archimedes.** Here is a sketch (Fig. 2) of one in my possession:

Fig. 2.



Archimedes, of Lesueur.

In the same rock which contains this fossil, or in the beds immediately beneath it, which often exhibit an oolitic structure, the

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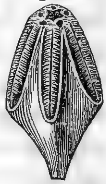
* I am not sure that Lesueur ever published his description of this fossil; but I know that while he resided here (at New Harmony) he engraved a plate containing several views of it, with that intention. He considered it, I believe, a new genus; but it may be only a new species of Retepora; if so, most aptly entitled *Retepora Archimedes.*

species of Pentremite here represented, (Fig. 3,)* is also a very common fossil. Three other species have been observed in this rock: the *Pentremites ovalis* of *Gold.*, the *Pentremites florealis* of *Say*, and the *Pentremites globosa* of *Say*.† The above corallines and Crinoïdeans are peculiar to these beds. Hence I have been accustomed to designate this group of rocks here in the west, as the *Pentremital* limestone, and its upper bed as the *Archimedes* limestone. I am not aware that these organic remains have been discovered in the Atlantic states. It is upon the Archimedes limestone that our coal measures rest. Rising from beneath the great Illinois coal-field,‡ these limestone beds circumscribe it nearly in its whole extent; and wherever visible, one or other of the above characteristic fossils can uniformly be found. These fossils afford a valuable and trustworthy guide, in determining the limits of our true coal-bearing rocks; since no workable seam of coal has ever been found, either in Indiana, Illinois, Kentucky, or Tennessee, beneath the rocks in which they occur. Without doubt some one of these fossils can be discovered in the vicinity of St. Louis at low water. I shall not fail to avail myself of the first favorable opportunity of investigating this matter.

Fig. 3.



Pentremites pyriformis.

* The Pentremites here represented, differs a little from the drawing of the *P. pyriformis* which I have seen; this specimen is much more angular or pointed where the interscapula joins the inferior extremity of the umbulacrum, and the striæ of the umbulacrum run slanting from above downwards, from the central furrow towards the interscapula, instead of from below upwards.

† A Pentremite, but of a species very different from any of these, occurs in a stratum of rock at the falls of the Ohio; the probable equivalent of the *Wenlock* formation of Murchison; the same rock described in the reports of western geologists, and popularly known here as the *cliff* rock.

‡ Delineated and described in my "Report of a Geological Exploration of part of Iowa, Wisconsin, and Illinois, made under instructions of the Secretary of the Treasury of the United States, in the autumn of the year 1839."

I take this opportunity of correcting an error with reference to this same coal-field, which has crept into a notice (in this Journal, Vol. XL, 1841) of a geological survey of Indiana, which, as geologist of that state, I had made to its legislature in the winter of 1838–9. In that notice (at p. 134) I am made to say: "Our bituminous coal formation is part of a great coal-field which includes nearly the whole of *Iowa, Illinois*, and eight or ten counties in the northwest part of Kentucky." It reads in my Report, "which includes nearly the whole of *Lower Illinois*, and eight or ten counties," &c. By a typographical error in the above notice which converts the word *Lower* into *Iowa*, I am thus made to say, that this coal-field extends over Iowa; while, in point of fact, only a few townships in the southern portion of that territory are included in the coal formation.

The whole Pentremital series is a remarkably pure variety of limestone. A quantitative analysis of a portion of the slab in which the foot-prints occur, gave the following result:

Carbonic acid,	40.80	grains.
Lime,	48.80	
Magnesia,	2.60	
Silica,	2.00	
Oxide of iron and loss,	5.80	
	100.00	grs.
Specific gravity,	2.67	

The color of the slab has not been quite correctly given by Schoolcraft. He describes it as of a "grayish blue tint;" but, on the exposed and worn surface, it has rather a purple tint; and, when fractured, is of a very light gray. I mention this because the blue tint is by no means characteristic of this group of limestones, but is peculiar to the lowest limestones of the Ohio valley, considered the equivalent of the lower Silurian rocks of Murchison, and the Salmon river and Trenton rocks of New York, and on account of this prevailing tint, frequently described as the "*blue* fossiliferous limestones." They lie from eight hundred to one thousand feet lower in the geological series than the Pentremital limestones now under consideration.

So much for the age of the rock in which these foot-prints are found. The question next presents itself, are they true fossils, or are they the work of art?

To aid in the solution of this question, I have given (in the plate accompanying this article) a correct representation of the slab, with the foot-prints and other marks, as they at present appear. That during the twenty two years since it has been quarried, no material or appreciable alteration seems to have occurred,*

* Nor does it appear that these impressions had changed in appearance while the rock was *in situ*. I quote from the letter of Col. Benton (an eye witness) to Mr. Schoofcraft, referred to in the extracts hereinafter given from the latter gentleman's article:

"The prints were seen when the country was first settled, and had the same appearance then as now. No tradition can tell any thing about them. They look as old as the rock; they have the same fine polish which the attrition of the sand and water have made upon the rest of the rock exposed to their action. I have examined them often with great attention. They are not handsome, but exquisitely natural both in form and position; square toed, of course anterior to the use of narrow shoes."

may be inferred from the following communication from a gentleman now residing here, to whom I am indebted for many valuable additions to my geological cabinet, and who visited and critically examined the specimen sixteen years ago, in company with several distinguished naturalists:

"In reply to your inquiries regarding the now famous limestone slab with its human foot-prints, I have to say, that in the year 1826, I visited and examined it repeatedly and minutely, and have a perfectly distinct recollection of its appearance at that time. I then compared the foot-prints with my own, placing my naked foot on the impressions. They corresponded very accurately both in outline and in the depressions, answering to the principal muscles of the foot and toes, except that the toes were somewhat more widely spread than mine. Mr. Maclure, Dr. Troost, Mr. Say and Mr. Lesueur, then residents of Harmony, examined the rock at the same time. They all agreed in opinion as to the artificial origin of the tracks, with good reason, I think; for the task seems to me more easy than the fabrication of many of our native vases and other antiquities.

"I can say with confidence that there is no perceptible difference between the appearance of the tracks now and in 1826, when I first saw them; and I find that others who were then in the habit, like myself, of seeing the specimen daily, coincide with me in this opinion. SAMUEL BOLTON."

Though Messrs. Maclure, Say, Troost, and Lesueur, appear thus to have agreed as to the artificial origin of these foot-prints, yet among the various writers who have broached the subject, others have expressed a very different opinion.

Mr. Schoolcraft, in the article already referred to, and which first introduced the matter to the scientific world, expresses his unqualified conviction that they are true fossils—the actual impressions of human feet made in the rock at some remote period, when it was soft enough to receive them. Here is his description of the foot-prints, and of the rock containing them, together with his reasons for the above opinion:

"The prints are those of a man standing erect, with his heels drawn in and his toes turned outward, which is the most natural position. The distance between the heels, by accurate measurement, is six and one fourth inches, and between the toes thirteen and a half inches; but it will be perceived that these

are not the impressions of feet accustomed to a close shoe, the toes being very much spread, and the foot flattened in a manner that happens to those who have been habituated to a great length of time without shoes. Notwithstanding this circumstance, the prints are strikingly natural, exhibiting every muscular impression and swell of the heel and toes, with a precision and faithfulness to nature, which I have not been able to copy with perfect exactness in the present drawing. The length of each foot, as indicated by the prints, is ten and a half inches, and the width across the spread of the toes four inches, which diminishes to two and a half inches at the ball of the heel, indicating, as it is thought, a stature of the common size.

"This rock presents a plain and smooth surface, having acquired a polish from the sand and water, to which its original position periodically subjected it. Upon this smooth surface, commencing in front of the tracks, there is a kind of scroll, which is two and a half feet in length; the shape of this is very irregular, and not equally plain and perfect in all parts, and would convey to the observer the idea of a man idly making with his fingers, or with a smooth stick, fanciful figures upon a soft surface; some pretend to observe in this scroll the figure of an Indian bow, but this inference did not appear to any of our party to be justified.

"Every appearance will warrant the conclusion that these impressions were made at a time when the rock was soft enough to receive them by pressure, and that the marks of feet are natural and genuine. Such was the opinion of Gov. Cass and myself, formed upon the spot, and there is nothing that I have subsequently seen to alter this view; on the contrary, there are some corroborating facts calculated to strengthen and confirm it. But it will be observed by a letter which is transmitted with these remarks, that Col. Benton entertains a different opinion, and supposes them to be the result of human labor, at the same period of time when those enigmatical mounds upon the "American bottom," and above the town of St. Louis, were constructed. The reasons which have induced him to reject the opinion of their being organic remains are these:

"1st. The hardness of the rock.

"2d. The want of tracks leading to and from them.

"3d. The difficulty of supposing a change so instantaneous and apropos as must have taken place in the formation of the rock

if impressed when soft enough to receive such deep and distinct tracks."

"To those who are familiar with the facts of sea and fresh water shells, ferns, madrepores, and other fossil organic remains in the hardest sandstones and limestones of our continent, the hardness of the rock and the supposed rapidity of its consolidation, will not present objections of that force which the writer (Col. Benton) supposes. But the want of tracks leading to and from them presents a difficulty which cannot perhaps be so readily obviated. We should certainly suppose such tracks to exist, unless it could be ascertained that the toes of the prints, when *in situ*, pointed inland, in which case we should be at liberty to conjecture, that the person making them, had landed from the Mississippi and proceeded no further into the interior. But no inquiry has enabled me to ascertain this fact, the circumstance not being recollected by Col. Benton and others who have often visited this curiosity while it remained in its natural position at St. Louis.*

"The following considerations, it will be seen, are stated by Col. Benton, as capable of being urged in opposition to his theory of their being of factitious origin.

"1. The exquisiteness of the workmanship.

"2. The difficulty of working such hard material without steel or iron."

"The strikingly natural appearance of these prints, has always appeared to me to be one of the best evidences of their being genuine; for I cannot suppose that there is any artist now in America possessed of the skill necessary to produce such perfect and masterly pieces of sculpture; yet what are we to say of the skill of that people who are supposed to have been capable of producing such finished pieces of art without the aid of iron tools? For let it be constantly borne in mind that the antiquity of these tracks can be traced back to the earliest discovery of this country, and consequently prior to the introduction of iron tools

* In reply to a second letter addressed to Mr. Anderson, in order to ascertain this point, he replies, that "the foot-prints were looking *towards the east and towards the river.*" Yet I do not attribute to this fact so much importance as Mr. Schoolcraft appears to affix to it. It seems to me quite as natural and likely (if we suppose but the single impression made) that an Indian should step out from his canoe backwards, and in that position shove it off again, as that he should make one step on shore, as if with the intention to land, and then step backwards again into his canoe. D. D. O.

and weapons among the aborigines. There are none of our Indian tribes who have made any proficiency in sculpture, even since the iron hatchet and knife have been exchanged for those of flint and obsidian. All their attempts in this way are grotesque, and exhibit a lamentable want of proportions; the same which was seen in the paintings and in the figured vases and pottery of the Asteecks of Mexico, when their towns and temples were first visited by the Spanish conqueror."

The learned Mantell, the distinguished geologist of southeastern England, coincides in opinion with Schoolcraft, as to the true fossil character of the foot-prints; but though he expressly refers to Schoolcraft's article, he seems to have overlooked the character of the rock; for he speaks of the impressions as being made in *sandstone.* The passage occurs in his "Wonders of Geology," already referred to, at p. 76, where he has copied Schoolcraft's drawing of the foot-prints. He says:

"In connexion with the occurrence of human bones in limestone, I will here notice a discovery of the highest interest, but which has not as yet excited among scientific observers the attention which its importance demands. I allude to the fact announced in the American Journal of Science, (Vol. v, for 1822,) of impressions of human feet in sandstone, discovered many years ago in a quarry at St. Louis, on the western bank of the Mississippi."

After giving the plate, he adds: "The above figure is an exact copy of the original drawing, and exhibits the impressions of the soles of two corresponding human feet, placed at a short distance from each other, as of an individual standing upright, in an easy position. The prints are described as presenting the perfect impress of the feet and toes, exhibiting the form of the muscles, and the flexures of the skin, as if an accurate cast had been taken in a soft substance. They were at first supposed to have been cut in the stone by the native Indians, but a little reflection sufficed to show that they were beyond the efforts of those rude children of nature; since they evinced a skill and fidelity of execution, which even my distinguished friend, Sir Francis Chantrey, could not have surpassed. No doubt exists in my mind, that these are the actual prints of human feet in soft sand, which was quickly converted into solid rock by the infiltration of calcareous matter in the manner already described. The length of

each foot is ten inches and a half, the spread of the toes four inches, indicating the usual stature; and the nature of the impression shows that the feet were unconfined by shoes or sandals. This phenomenon, unique of its kind, is fraught with so much importance, that I have requested Prof. Silliman to ascertain the nature of the sandstone, and the period of its formation."

The shrewd Leonhard, though of a country where traditions of the marvellous commonly find no little favor, is utterly sceptical in regard to this matter. His remarks are brief, and somewhat tinged with severity. He says:

"Impressions of the human foot are also said to exist in rocks of a calcareous nature on the banks of the Mississippi, in the state of Missouri. As is said, the impressions partly must have been made by a man while standing still, who, judging from the form and extended spread of the toes, could not have been accustomed to having his foot protected, and partly, there are evident marks about the impressions indicating that the feet were covered after the fashion of the Indians. The reporter of the story mentions expressly, *of course,* that the tracks are so distinct, that the impressions of the least muscle can be recognized; but this very circumstance casts suspicion on the whole narrative; and it appears probable that these marks were artificially cut in the rock. But that which excites the greatest doubt in this and other instances is, that such phenomena, until now, have occurred so isolated; the footsteps of the walking man cannot be followed farther."

With opinions so variant before me, and such names arrayed on either side of the question, it is with diffidence that I shall proceed, after describing the slab in my possession, to venture my opinion as to the probable origin of the impressions it contains.

While I cannot unite with the learned German professor in the implication conveyed by the italicising of the words "of course," in the above extract, not doubting that Mr. Schoolcraft sought faithfully to embody the impressions made upon him by the appearance of the phenomenon, yet I must be permitted to remark, that I am unable fully to endorse the unqualified expressions of admiration in regard to the matchless workmanship and inimitable fidelity of execution which the inspection of these foot-prints has called forth in various quarters. I may be supposed to regard the specimen which is the subject of these eulogiums, certainly

with no unfavorable eyes. To find myself the possessor of a fossil unique in the cabinets of Europe or America, or even of a specimen of aboriginal sculpture that should put to shame the best efforts of Chantrey's chisel, was a prospect calculated to quicken my perceptions of its merits and beauties, or to bias my judgment in favor of its genuine character. Nevertheless, after the most critical inspection, I regret to be impelled to the confession, that I see no incredible display of anatomical knowledge or artistical skill; nothing more than we may fairly attribute to the observant and ingenious Indian, dependent for his very life, as the forest warrior daily is, on an intimate and familiar acquaintance with tracks of every description, and more especially, with those of his own race. The representation is, indeed, easy and natural; at the heel, at the ball of the foot, at the outer edge of the sole opposite the instep, the impression of the muscular elevations is given with fidelity, yet without any delicate details, minute lines of demarcation between the muscles, flexures of the skin or similar minutiæ.

The appearance and dimensions of the foot-prints coincide otherwise with Schoolcraft's description of them. The greatest depth of the impression is about one sixth of an inch. The rock, as already stated, is a very compact limestone of a gray color, and its general surface has been ground down level, and even partially polished by the attrition of sand and water. The polish has extended to the impressions equally with the rest of the slab, and gives to them a smooth and finished appearance. The scroll, also alluded to by Schoolcraft, (of no determinate figure, as may be seen by the plate,) is of inferior workmanship to the foot-prints. The surface of the foot-prints themselves is somewhat broken by small superficial cracks and indentations; and deeper fissures and inequalities are distributed over the rest of the slab. It was quarried in two pieces; the fracture is shown in the drawing.

After a close inspection of the slab itself, a careful examination into its geological position, age, and origin, and a patient review of the arguments of the various writers already quoted, I have come to the conclusion, that the impressions in question are not fossils, but an intaglio of artificial origin. This opinion is based on the following considerations.

1st. Because the foot-prints are not continuous, but isolated.

2d. Because (as it would seem) this is a solitary instance of human foot-prints in solid limestone.

3d. Because of the difficulty in conceiving the sudden consolidation of compact limestone rock, after having received, while in a plastic state, such impressions.

Lastly, and chiefly, because of the age, nature, and position of the rock, and because no human remains whatever have hitherto been discovered in any similar formation.

The isolated position of our foot-prints affords a strong presumption against their fossil origin. "The footsteps of the walking man cannot be followed farther." Mr. Anderson distinctly states, that careful search has failed to detect any other human tracks in the vicinity of St. Louis. Were the tracks under consideration those of a bird instead of those of man, the fact of there being but a single pair might be accounted for under the supposition that a winged creature lit and rose from the same spot; though, so far as I know, even ornithichnites have always been found continuous; but we can hardly imagine under what circumstances a man could impress, thus evenly and naturally, a single pair of foot-prints on a soft and yielding surface, without leaving thereon other traces of his steps.

The limestone stratum containing them, is not a partial bed, but an extensive layer, necessarily deposited at one and the same time. There seems, therefore, every probability, that other foot-marks would have been discovered on adjacent parts of the rock, had those under consideration been actually made by human feet in plastic calcareous matter.

If the specimen in my possession be unique of its kind, that circumstance also is strong evidence against its fossil origin; and it would appear that it is so. Every writer, American or European, who treats of impressions of human tracks in solid rock, alludes to the specimen which forms the subject of the present article; all expressly referring to the St. Louis locality, and apparently unacquainted with any other. Yet we have already seen, that in that vicinity, none but the foot-prints in my possession have been discovered.

Until other similar impressions, or other human remains shall be found in rocks of a similar character, the presumption must remain strong against the fossil origin of these.

If, as Mantell seems to have imagined, the intaglio were in sandstone, the difficulty in supposing it a fossil would be lessened. The tracks of marsupialia, birds, and reptiles hitherto discovered, occur, I believe, uniformly in that species of rock.*

Of the materials which compose sandstone we have daily examples in a state capable of receiving an impression, and it is well known that, by the infiltration of calcareous matter, beds of sand may, in a comparatively short period of time, be consolidated. There is, therefore, not the same difficulty to encounter, in explaining the occurrence of foot-marks in sandstone as in pure calcareous matter, which, although it frequently encrusts, is seldom seen on dry land in a plastic state.

But all these previous arguments are weak, compared with that based on the origin, position and age of the rock under consideration, and on the fact, that no human remains of any description have ever been discovered in any similar formation.†

We have ascertained, that the organic remains taken from the slab itself are marine shells. We find, moreover, that it is overlaid by other beds of limestone containing fossils, also the former inhabitants of an ancient ocean. The inference is inevitable, that these various beds were deposited at the bottom of the sea. But unless we imagine the stratum containing the foot-marks to have been raised from the bed of the ocean, while still in a plastic state, to have received the impress of the human foot, and to have been again submerged, (the tracks remaining uneffaced until gradually covered by other beds of limestone,) how can we even conjecture that these prints were impressed on the nascent rock?

No remains of man or his works, have ever yet been found, except in the most recent deposits. Yet the limestone composing our slab is of immense antiquity; anterior, even, to the coal formation. Between this ancient limestone and the recent one of Guadaloupe, as well as all other rocks in which have been detected any traces of man or his handicraft, there intervene six

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* The only tracks ever discovered in solid limestone are, I believe, of Crustacea, and therefore of marine origin.

† The human fossil bones found in Guadaloupe are no exception; for they were discovered in a species of limestone *now in process of formation*. This modern rock is composed of "consolidated sand and recent shells;" the shells of the same species now existing in the adjacent seas; and bears no analogy whatever to the ancient solid limestone here treated of.

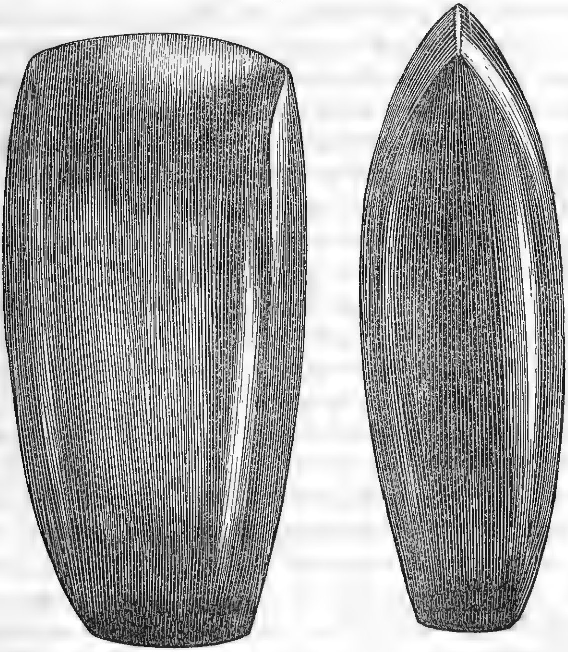
great geological formations; the coal measures; the new red sandstone; the lias and oolite; the chalk; the tertiary, and the diluvium. These deposits form a geological series commonly three or four thousand feet in thickness, and embrace six vast and strongly marked epochs, during each of which, distinct races of animals have successively arisen, existed, and become extinct. The time necessary to these changes we can hardly conceive, much less calculate. Add the supposition usually entertained by geologists (based on the gigantic and ultra-tropical vegetable growth necessary to produce the superincumbent beds of coal) that the temperature of the globe and its atmosphere during the deposition of these secondary formations, was unfit for animals with lungs; and the idea of a human fossil existing in ancient limestone must appear at variance with the best ascertained facts which the industry of the modern geologist has supplied to us, and with the most legitimate inferences to be deduced therefrom. Nothing less than some fossil phenomenon of a character so unequivocal that its origin admits of but one explanation, ought, under these manifold difficulties and improbabilities, to win our confidence or command our belief.

True, that the attempt to account for the artificial origin of these impressions is not without its difficulties. Yet of difficulties, as of evils, let us choose the least. It appears to me much less improbable that some aboriginal artist should have exhibited unlooked-for skill in intagliating a rock, than that man should have been coëval with the crustacea.

The argument deduced from the excellence of the workmanship would be more difficult of reply, did these impressions represent almost any part of the human body other than the foot. What simpler or better outline to guide the inexperienced hand of a native workman, than the mark which is left on a smooth and dry rock by a moistened foot. With such an outline as his first guide, and with the constant opportunity of testing the accuracy of the progressive work, by applying to it the naked foot, there is surely no insuperable difficulty in supposing an aboriginal sculptor, (imbued perhaps, with that inborn love and taste for his art, which we are not justified in attributing exclusively to the Caucasian variety of the human race,) to have succeeded, even with such rude tools as an Indian could command, in producing a natural and faithful representation.

The precise character of the tools which may have been employed, we cannot determine; but this seems evident; a people capable of fashioning figures of porphyry, arrowheads of flint, and mortars of granitic rocks, must have had tools capable of excavating a fraction of an inch out of a small surface of limestone. I have in my possession, an axe found amongst the antiquities of this country, wrought out of a boulder composed of hornblende and minute crystals of felspar; a rock which yields with great difficulty to the knife. This Indian relic has an admirable finish, shows not the smallest scratch or tool mark, reflects light, and is, to the touch, smooth as polished marble. I have endeavored here to represent it, (Fig. 4,) that the reader may judge of the symmetry

Fig. 4.



Indian axe, of hornblende rock.

it exhibits, the fine edge to which it is brought and the labor necessary to work so well-finished an instrument out of so hard a material. The race that could make such an axe out of a tough hornblende boulder, may well be conceived capable of engraving on a limestone slab impressions as skilful and highly finished as those before us; more especially as much of the finish observable

in the intaglio is attributable to the polishing action of the current of the Mississippi, bearing with it fine gravel and sand. This cause is alone sufficient to explain the removal of any scratches, or other tool marks of an unskilful hand, even if we suppose such to have been left by a native engraver.

We must admit the probability, that the aborigines of Northern America were unacquainted with the use of iron tools,* yet by water itself in the course of time, an impression may be made on the hardest rock. The hardness of flint is 7°, while that of limestone is but 3°. Where is, then, the improbability, that the patient Indian, who, in the intervals of war or the chase, is known to spend months in carving some favorite weapon or frivolous ornament, should have gradually hollowed out these foot-prints? How incomparably easier such a task, than to produce those complicated ornaments on altar-pieces and idols in Central America, which the enterprise of Mr. Stephens has recently submitted to the inspection of the curious? The Western hemisphere once produced its sculptors, persevering, skilful, even tasteful and delicate. If they have left their handiwork in Guatimala and Yucatan, why not also on the banks of the Mississippi.

The slab which is the subject of these enquiries was quarried, it will be recollected, from a ledge of rock at a point on the very edge of the stream when at its lowest stage. The present site of St. Louis, it will also be borne in mind, was a common gathering place of the neighboring Indians, as the adjacent mounds abundantly testify. May we not, then, with some degree of confidence, hazard the conjecture, that our impressions were an aboriginal record of extreme low water, as observed by the Indian race, at their favorite resort on the banks of the Father of Waters —their own unequalled and magnificent *Me-scha-si-pi?*

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* Yet it is possible that our specimen might have been chiselled by the aid of iron or steel tools. Neither tradition nor its present appearance may justify us in positively dating its origin back beyond a couple of centuries. But Bancroft, in his History of the United States, reminds us, that Soto and a party of Spaniards ascended the Mississippi above New Madrid in the year 1541; and dispatched an exploring party to examine the regions farther north. This or some other party—perhaps some of the persevering Jesuits, who at a very remote period penetrated these wilds—may have reached St. Louis at that early day, and introduced iron tools among the Indians. Nay, it is within the bounds of possibility, though certainly improbable enough, that some of these adventurers themselves were the sculptors.

Art. III.—*On the Identity of Pyrochlore with the Microlite of Prof. Shepard;* by J. E. Teschemacher, and A. A. Hayes.

Read before the Chemical Society of Boston, March 14, 1842, and communicated for this Journal.

Feeling confident from a close examination of several crystals of the mineral named Microlite by Prof. C. U. Shepard, which I obtained from Chesterfield, Mass., the locality mentioned by him, that it was identical with the Pyrochlore discovered by Otto von Tauk, examined and named by Berzelius, and found in several European localities, I handed to Mr. A. A. Hayes about one and a half grains of selected crystals, which at the request of this Society he kindly undertook to analyze.

Below is the result of his analysis, as also that of Pyrochlore by Wöhler; it will be seen fully to confirm my conjecture. I have therefore merely to add, that I found crystals varying in color from transparent straw-yellow to brick-red and dark black, as might be expected in a mineral, several of whose constituents are probably mechanical mixtures; the transparent and smaller crystals, being beautifully modified, as described by Shepard, on the solid angles and on the edges of the octahedron. The largest crystal I found was that exhibited at the last meeting of this Society, and which if extracted from the green tourmaline in which it is imbedded would probably weigh three grains; it has modifications on the edges.

Analysis of the Microlite, by A. A. Hayes.

Pyrognostic characters.—The surfaces of the fractured crystals of this mineral, present an inequality of texture, indicating a mixed composition. The colors are also irregularly distributed, and vary from light yellow to clove brown. When heated in a tube, a small quantity of aqueous vapor appears, having an empyreumatic odor; as the vapor escapes, a translucent fragment of a clove brown color and glassy lustre becomes opake and of a fine canella color, with pearly lustre. In the forceps and exposed to the outer flame of the lamp, the edges of a fragment fuse into a canella colored enamel, which in the reducing flame becomes darker, and finally of a clove color. The outer flame re-

stores the brown color again; these changes constitute a distinctive character. With borax on a platina wire, the mineral fuses with slight effervescence, the outer flame gives a glass which while hot is reddish brown, but becomes pale yellow as it cools; the globule in the reducing flame remains clear, and when cold is of a pale green color, when flamed a white enamel is produced. The darkest colored fragments give a yellowish enamel, but the reducing flame gives as before a light green glass. With a particle of oxide of iron the borax globule in the reducing flame gives the characteristic reactions of ferruginous titanic acid.

Phosphoric salt gives in the outer flame a reddish yellow glass whilst hot, which becomes green on cooling; the reducing flame gives a clear fine green glass. Tin does not develope the color of titanic oxide. Soda does not show the presence of manganese, but the mineral gives a deep green color to the fused mass while hot, which becomes yellowish brown on cooling. One grain of the mineral which had been dried was decomposed, the titanic acid carefully separated and dried, it weighed 80; this had the chemical characters of pure titanic acid.

The solution of the oxides from the titanic acid gave a precipitate of sulphate of tin, when treated with sulpho-hydric acid, and the sulphate oxidized before the blowpipe gave with soda a globule of tin. Sulpho-hydrate of ammonia gave a black precipitate, which when roasted contained oxides of iron and uranium, with traces of oxide of cerium. The fluid remaining gave with oxalate of ammonia, a precipitate which was converted into sulphate of lime, equivalent to 0.08 lime. Thus,

Titanic acid,	80.
Oxide of tin, iron, cerium, uranium,	11.8
Lime,	08.2
	100.0

This mineral is therefore identical with that analyzed by Wöhler. The absence of protoxide of manganese and water, and the smaller proportion of oxide of iron in this specimen, as indicated by the blowpipe experiments, will account for the larger proportion of titanic acid given in the analysis.

Analysis of Pyrochlore, by Wöhler.

Titanic acid,	62.75
Lime,	12.85
Protoxide of manganese,	2.75
Oxide of iron,	2.16
Oxide of uranium,	5.18
Oxide of cerium,	6.80
Oxide of tin,	0.61
Water,	4.20
Fluoric acid and magnesia,	traces
	97.30

Art. IV.—*On the Wisconsin and Missouri Lead Region;* by James T. Hodge.

The following observations upon some of the mineral resources of Wisconsin and Missouri, were made in the course of a tour through parts of the western country the last season. My attention having been directed by the company by whom I was employed, to ascertain the probable importance of a few mines only, I was unable to devote much time to the elucidation of the general geology of that country; this I am happy to see in the last number of the American Journal, is taken up by one well able to connect its formations with those of our eastern states.

This region, according to Messrs. Owen and Locke, comprehends sixty two townships in Wisconsin, eight in Iowa, and ten in Illinois, its extreme length from east to west being eighty seven miles, and width from north to south fifty four miles. Though the "cliff" limestone, the rock formation that contains the lead ore, occupies a greater extent of country, it is in this portion only that circumstances seem to have been favorable for the production of fissures containing the ore. This rock is not broken through by granite or other rock of igneous origin, as the limestone of Missouri is, that there produces lead ore; and its calcareous character is more constant than this, which frequently passes into a true siliceous rock. Its strata appear uniformly

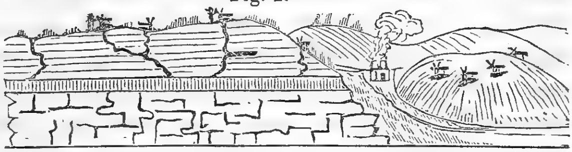
horizontal, until by tracing them some miles, a prevailing dip to the south is discovered.

The lead region is a rolling hilly country, the hills sometimes covered with an open growth of oak, but as often entirely free of timber, and clothed with the tall prairie grass only. The summits maintain a general level, except where it is broken by the "natural mounds," (the two Blue mounds, the Platte mounds, Sinsinava mounds, &c.) which rise several hundred feet above it. In these the limestone appears more siliceous than is noticed elsewhere, and its superior hardness may in part have been the cause of these mounds remaining like monuments of the devastating currents that must have given the surface around its present form; while the huge blocks, tipped out of their horizontal position, lie on the steep sides as additional evidence of the wasting waters. Yet these are the only evidences that such a force has been in operation; for in the western part of Wisconsin, there are no primary bowlders, no loose rocks but those which once evidently formed a part of the formations on which they now repose; in the eastern part of the territory, however, and to the west in Iowa, such bowlders are not wanting. Whether this region may have been in part protected by the high lands to the north of it, and the progress of the bowlders been thus intercepted and turned aside, must be determined by more extended observations. This supposition is rendered more plausible by the unusual course of the Wisconsin river, it suddenly turning from a south to a west direction. In its valley, however, where it flows towards the west, no bowlders are found except the small pebbles brought down by the river itself.

Throughout the extensive tract defined as the lead region, lead ore may be sought for with prospect of success on every township and on almost every square mile. And fortunately it is so well watered, and the little streams have so rapid a fall, that power for furnaces may almost always be obtained near the mines. New discoveries are continually made, and with every one further light is thown upon the true character of the ranges of fissures containing the lead and copper ores; by which result they can be traced with greater certainty from one tract to another, without depending entirely on the present imperfect system of "prospecting."

Beneath the cliff limestone is a thin stratum of blue limestone, and this rests on a body of brown sandstone. As one goes from the southern townships of Wisconsin towards the north, this blue limestone is observed to become higher and higher in the hills, and the lead diggings to be every where above it. Though the sandstone rocks come out in bold bluffs on the sides of the hills, no veins of ore are ever found in them; but in the cliff limestone above, they are found, though the rock and its fissures lie hid under a great depth of soil. The section annexed (Fig. 1) represents this order of superposition, the character of the fissures, and about the relative proportion that the three rocks bear in the hills near Mineral Point.

Fig. 1.



These fissures are of every degree of width, from fifty feet down to thin cracks; all of them do not contain ore; the large chambers, when they have any mineral in them, are lined on the walls with a coating of lead ore, seldom over a foot thick, while the interior is filled with clay. Sometimes across the crevices run horizontal layers of galena; and again it occurs in loose "chunks" in the clay of the fissures or of the soil above, and again it runs in a vertical sheet down, or still again filling narrow fissures in the appearance of a vein and of a bed in the solid rock. But the lead is not the only ore these fissures contain; mixed with it in every proportion, and even sometimes getting the better of the galena and shutting it out completely, occur both the carbonate and sulphuret of zinc; the one known to the miners by the name of "dry bone," the other "black Jack." From the abundance of the carbonate of zinc, and its being an ore that when clear yields about 60 per cent. of the oxide, it seems probable that it will sometime become an object of importance; now it is considered a great obstruction whenever met with, and the galena when mixed with much of the zinc ore, brings an inferior price.

The direction of the fissures downwards is as variable as their size and shape. They run like cracks through a rock—sometimes vertically, sometimes inclined, and sometimes horizontally

between the strata. But in all cases on reaching the sandstone, they are, as far as is yet known, unproductive. They are followed when they are found to yield three inches of galena, that being the least vein it is thought worth while to pursue through rock; and it is very rare indeed that a continuous vein is found exceeding one foot in thickness. The horizontal direction of the fissures is more uniform; those producing the most ore almost universally running nearly east and west. Near Mineral Point, some fissures running north and south produce good ore, but they are for the most part horizontal beds (of limited width) between the strata, and out of these directions it is rare to find a productive fissure. The smelters think they can distinguish the ores that are found in different fissures—that from an east and west fissure being perfectly crystallized, of a smooth surface, striæ indistinct; that from a north and south fissure, of crystalline structure, with two sets of striæ very distinct, crossing each other at right angles; and the ore from a quartering fissure crystalline, with many sets of striæ crossing each other obliquely; and to some extent I had opportunity of proving their observations correct. The fissures appear to be limited in length to within a few hundred feet, and to lie in ranges which extend at right angles with the direction of the fissures. In the neighborhood of Mineral Point many of these fissures are opened and mined, and the "diggings" are seen to extend with little irregularity in a north and south belt, that part to the west producing lead ore; half a mile to the east the fissures containing copper ore, and still further east a mile or more, hematite iron ore abounds in them.

The deepest shafts that have been sunk on these fissures are about ninety feet; and at Mineral Point they may be worked to that depth without the water being troublesome. But as these deep shafts were sunk on the highest ground, the bottom of them hardly reaches the sandstone.

Copper Ores.—The copper ore is similarly situated to the lead ores, either in wide fissures or in thin veins running through the rock. As many as four of the little veins not exceeding two inches in thickness have been found running about east and west on different parts of the mining ground. The ore in these is a mixture of the sulphuret and carbonate. Besides these, which are not considered important, there is a large fissure, in places fourteen feet wide, that has been traced about a quarter of a mile.

It is on the old Ansley tract, and extends in a westerly direction towards Mineral Point. For about the depth of fifteen feet the fissure was found to be filled with "gossan" and lumps of sulphuret and carbonate of copper mixed in it. Below this depth is clay with a little ore scattered through it. The lumps above were of all sizes up to two hundred pounds weight. No shafts were ever sunk to prove this fissure at greater depths; but there is every reason to suppose that it will be found productive in other parts beside the strip near the surface. The little rock veins prove that the ore belongs to the formation as much as the lead ores, and in whatever way it may have been brought up from below, it is likely to have formed other deposits in the fissure worth looking after.

In the report of the geology of Cornwall, Devon and West Somerset it is remarked that "the per centage of cases is considerable when an iron ochreous substance named gossan prevails, and copper ore is connected with it, and it may be said that the instances are very rare where copper ore is found in fair quantity in a lode, without gossan having been discovered on the back or upper part of that lode." p. 326.

The sandstone lies at about the depth of one hundred feet below, and although in it we are not to expect to find the fissures or cracks (if they have dwindled to them) productive, still there is sufficient room above for a large supply of ore. It is said that 1,640,000 pounds of ore (probably including unwashed and gossan) have been raised from this fissure; 50,000 pounds were sent to England, and 100,000 pounds are now on the bank of the Mississippi River at Sonapee; 620,000 pounds have been taken to the old furnace, and the little one at New Baltimore, and between 500,000 and 600,000 pounds remain now on the surface at the mines. This is evidently a very rude estimate. It is also said that the ore sent to England yielded twenty per cent. of copper; at any rate, however, it brought in a bill of expense. Were the ore well washed from the clay and iron ore mixed with it, and the lump ore carefully broken up and washed, there is no reason to doubt that it may be smelted with profit; but all the operations so far have been badly conducted. There was no uniformity in the quality of the ores used, no judgment exercised concerning the quality or quantity of flux, and the smelting was carried on in furnaces that must be blown out every twenty four

or thirty six hours, in order to put in a new lining, the sulphurous vapors and strong blast soon destroying the back wall. In this manner I saw some copper smelted in a furnace at New Baltimore, which, as they said, cost only ten dollars! The high price of fuel would render a reverberatory furnace expensive, particularly, as the ore would then be first roasted. This is now neglected, the ores being run down at once in a little blast furnace. Whether successful experiments with these ores might not be conducted by making the throat of the furnace flaring, that the ores might have time to become partially roasted before getting down into the smelting heat remains to be proved. Though the English methods may be the most perfect for smelting the ores clean, I believe they will not be found the most expedient in Wisconsin.

It is difficult to form any correct judgment concerning the per centage of these ores, particularly the gossan, for they are continually changing their relative proportions of copper, iron and clay, so that a few analyses would not decide the matter. According to the report of Dr. Owen "three *average* specimens" of the lump ore yielded respectively 23, 24⅓, and 35.7 per cent. of copper; and in the same report he says that the gossan yields by analysis from six to nine per cent. of pure copper.

In this uncertain state of the value of these mines, it would not seem advisable to make much outlay in working them; still as a furnace may be built in connexion with lead furnaces without much extra expense, and whether the copper business succeeds or not, no great risk will be incurred—and also as the miners are disposed to take upon themselves the risk of proving the mines, provided they are insured a market for the ore at prices agreed upon, according to its quality, between themselves and the smelter, they certainly are worthy of attention, and authorize a cautious investiture of capital to prove the business.

Some additional encouragement is afforded from the fact of other discoveries of copper ore having been made in the territory, though none of them have yet proved to be important. I saw one of good quality from the Blue River country, and visited a mine, a thin rock vein, near the Peccatolica, about five miles north of the Illinois line.

In this neighborhood I discovered some fire clay apparently of excellent quality, which may be of no little importance in making

fire bricks for linings for the furnaces. It is an alluvial bed six feet thick, at Winslow on the Peccatolica, where it crosses the state line.

Account of the lead business of Wisconsin.—The lead ore is sought for by the miners at their own risk. Wherever they think there is a prospect of discovering a "lead," there they commence their operations; two of them joining to sink experimental shafts. Sometimes they spend a year in unsuccessful exploring, but with the expectation of being repaid for it all by a happy discovery. If they strike a "lead" they offer the ore to the nearest smelters at the market price, and the owner of the land comes in for his share of one fifth of the ore raised, but the original discoverers are allowed by the custom of the country the other four fifths. Should the discovery promise to be an important one, other miners are attracted to it from the country around. They come in companies proportioned to the reputation the new diggings have acquired, and in a month's time a little village of log cabins with a population of three or four hundred people has sprung up in the midst of what was just before wild woods or an uninhabited prairie. The new comers not having been instrumental in making the discovery, have an inferior claim to their predecessors, who are not permitted by "the rules of the mines" to monopolize more than a certain number of square rods around their successful shafts. As each one comes, he selects his own ground, and so many rods are staked out for his operations, but of the ore he raises, *four* fifths go to the proprietors of the land, and he is allowed but one fifth. The proprietor may persuade miners to come and work in this way, or he may hire them on fixed wages, but the former is considered the preferable plan, because the miner is induced by it to raise as much ore as possible, and in the latter it is no object to him to take out any at all, and it is therefore frequently the case that when working on wages they will carefully conceal a rich lead, and work in unprofitable rock until the proprietor abandons the diggings, and years perhaps have passed, when they will come back and make a new discovery there, and work it on shares. The miners sometimes sell their "prospect," while it generally comes into the hands of the proprietors, who then receive their greatest share of four fifths, or it is bought by other miners, who are entitled to the same privileges as the original workmen. All mineral raised

on government land should by law be subject to a tax of ten per cent., paid in lead by the smelters, and the lands are not subject to entry. But since the year 1835 none of these dues have been collected, though a government superintendent has always been appointed for this purpose, and now no attempts are ever made to collect the ore rents, neither are any questions asked at the land offices whether or no the lands about to be entered are known to contain mineral. It is generally believed that a law will be passed taking off all restrictions on mineral lands, both as to entry and subsequent claims for ore rents.

The smelters are for the most part, a distinct class from the miners. They are men of a little capital, who expend it in establishing one or more furnaces in what they judge a suitable locality, both for convenience of water power and proximity to mines that promise to be permanent in their supply of ore. Their business is to visit the mines, and every day bargain for so much mineral, sometimes of one set of miners, sometimes of another. The ore is weighed out by the miners, the smelter sends his teams for it, and has it weighed again at the furnace. The price fluctuates with the price of lead, with the greater or less amount of competition, either among the smelters or miners, and varies with the distance from the shipping port, which is now Galena in Illinois. As the smelters generally have no capital to spare, they must either sell their lead as they make it for what it will bring, or if they ship it themselves they are compelled to cease their operations until they receive their returns, for they are obliged to pay for their mineral in cash, to secure the good will of the miners, and it may be ten months before they receive the proceeds of their lead sent to the Eastern market. On this account, and from the unsteady character of the miners, who wander about, as their fancy directs, from place to place, there are few furnaces that keep in blast for a great length of time; they go for a week, or a month, or six months, and stop as irregularly. No supply of mineral is ever bought up when it is low, though lead is often kept stacked up, waiting a higher price, and the furnace out of blast for want of means to buy more ore.

The furnaces are much improved within a few years past. The ore was formerly melted down on log heaps and a small portion of the metal thus extracted at a great waste of fuel. Now they are of the most approved forms and constructed with par-

ticular regard to the most economical methods of smelting as to fuel and labor. They make use of the *reverberatory* furnace with its modification, the *cupola*, the *blast* furnace and the *slag* furnace.

The *reverberatory* is much like the common reverberatory furnace for puddling iron and smelting other ores. The ore is supplied either through a hopper on the top, or through the holes on the sides, which serve also for admission to the pokers used for stirring up the charge. The hearth is covered with old cinders beaten up, and it inclines back from the fire, so that the metal runs out at the end, under the chimney. In England where these furnaces are extensively used they are supplied with bituminous coal for fuel, but here they must make use of wood, and from the great consumption of it this class of furnaces is only resorted to where wood is of little value, and water power cannot be obtained.

Another objection to them, besides the consumption of fuel, is that they do not smelt the ore clean, the slag being nearly as rich as the ore originally was; and it is therefore necessary to have a slag furnace connected with them. It is supposed from rude calculations that an ore worth about eighty per cent. will yield in a reverberatory about sixty five, and that the slag produced will contain from thirty to forty per cent. of lead. The following is an estimate of the working and produce of O'Neill's furnace, about two miles south of Mineral Point. It is worked eighteen hours out of the twenty four by two shifts; each shift, two hands. The charge varies from 9,000 to 12,000 pounds of ore, it sometimes requiring three, sometimes four charges of 3,000 pounds each, according to the poorer or better quality of the ore. The consumption of fuel is about two cords a day, and the produce is from seventy five to eighty three pigs a day of seventy pounds average weight. The two head smelters' wages, fifty dollars per month each; two back hands twenty five dollars, and the board of them all beside. The average price of ore is probably about the price it was selling for at Mineral Point in September, fifteen dollars per thousand pounds; lead was then worth at Galena three cents per pound.

Estimate of Expenses of Reverberatory Furnace.

Wages per month, as above, $150. Board four hands four weeks, $48,	$198 00
Ore 10,500 lbs. daily for 26 days, at $15 per 1000 lbs.,	4095 00
Wood, 52 cords, at say $2,	104 00
Hauling ore to furnace, 273,000 lbs. at say 75 cts. per 1000,	204 75
Hauling lead to Galena, 79 pigs daily, at 20 cts. per 100,	287 56
	4889 31
Worth of 2054 pigs of lead at Galena,	4313 40

Besides this produce is the amount of slag made, of the value of which it is impossible to make a correct estimate. The only way perhaps by which we may approximate it, is as follows:—Supposing the ore originally to be worth 75 per cent. of lead, the 273,000 pounds then contain 204,750 of metal, of which 60,970 are missing; allow ten per cent. for loss in the furnace, (escaping in fumes of the oxide and sulphate of lead,) and there remain 54,873 pounds of lead, which must be in the slag. Taking average pieces of this slag, which consists of a mixture of pure lead, unaltered galena, sulphate of lead, and earthy matters, grinding them thoroughly, and submitting portions of the powder to analysis, fusing one portion with carbonate of soda, and digesting another many days in dilute nitric acid, and then fusing the insoluble remainder with dry carbonate of soda, I obtained the following result, neglecting the sulphur and sulphuric acid:

Silica,	15 per cent.
Sulphate of lead obtained by the action of fuming nitric acid on the sulphuret, precipitated by hydrosulphuric acid, gave lead,	34.30 "
Peroxide of iron,	24.53 "

The 54,873 pounds of lead require therefore 160,000 pounds of slag, when this contains 34.30 per cent. of lead. It seems a fair allowance that this should be worth one third as much as the original ore, or $5 per 1000 lbs.=$820. Adding this sum to the value of the lead made, we have $4313 40+$820= $5133 40

From which deducting the expenses, . . . 4889 31

Leaves as the profit per month, ... $244 09

This estimate gives a small return for the amount of capital employed, but it must be observed that it is made out under the

worst circumstances in which a smelter can be placed; for without considering the highest wages that are paid, high board, and the heavy item of hauling ore, which may be much diminished with the distance, suppose ore to be raised on land owned by the smelter, discovered by others; he saves at once $829, and his monthly profits increase to $1,063. Suppose him to have made the discoveries with his own hired miners on his own land, and he then saves $3,276, making his profits for the month, $3520. But this calculation is made rather to show what *might* happen than what has, or is likely to. It is one of the chances of the business in which to some extent, several smelters have been fortunate; but for the most part they would be glad now to obtain half the ore they require, off their own lands, as the result of the discoveries of others.

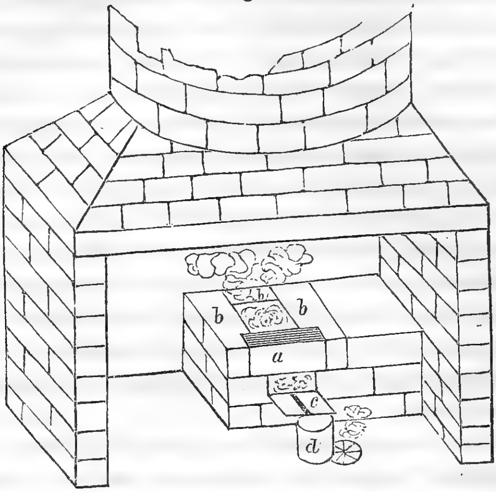
The *blast* furnace is like those of the same name in general use in England; though coke is the only fuel there supposed to be suitable for it, charcoal has here been found equally good and is in general use.

The following sketch (fig. 2) will give a general idea of this furnace, and a minute description of its parts with working sections may be seen in Elié de Beaumont's "Voyage Metallurgique, &c." The blast is raised by the simplest machinery—a crank on the end of the axle of the water-wheel working either the common double bellows or the cylindrical bellows; while another pair is often connected with the same wheel to blow a slag furnace or a copper furnace, as at New Baltimore.

Three hands at a time are required to work this furnace; the head smelter, whose duties are not quite so arduous as those of the head smelter of a reverberatory, and whose pay is not so high; a "back-hand," who assists the smelter by throwing in charcoal and wood and ore after he stirs the fire, and an assistant who prepares the materials. They work one shift which ends when thirty pigs are made, and this requires from eight to ten hours. Then another set of hands come on and work another shift. Some smelters however, employ but one set, still their day's work is over when the thirty pigs are run.

The process is this: a fire is made in the morning of billets of wood carefully arranged in the fireplace, the blast is put on, and charcoal added, as the wood burns away; ore is then thrown on in small quantity, together with a little lime. The ore has first

Fig. 2.



a, Cast iron plate in front of the fire.
b b, Cast iron blocks forming the sides and back of the fireplace.
c, Sloping hearth down which the melted lead runs into the pot.
d, Pot to catch the metal.

Across the whole front,	11 feet 6 inches.
Depth,	8 " 9 "
Height of furnace,	2 " 8 "
Width of fireplace,	1 " 7 "
Depth, " "	1 " 9 "
Height above hearth,	1 " 4 "

been prepared by breaking it up either with a hammer or between a pair of cast iron rollers, into pieces about the size of pigeon's eggs, and if mixed with much clay, it must also have been washed in a stream of water. It is allowed to remain a few moments on the surface of the fire, while a part of the sulphur is burnt out and carried off, in part combined with the oxygen, supplied in large quantities by the blast, which comes in from behind through the fire. When the mass begins to melt and becomes consolidated, the head smelter with a long iron bar pries up the whole body, working under the iron plate in front of the fire; he then finishes the operation by similar stirring above, and as he opens the mass the back-hand throws a handful of billets of wood under the whole, against the back wall and the tweer, and immediately adds more charcoal and more ore. This remains on the surface a few moments and then the same operation is repeated, and so on. When the material clogs up and forms lumps, they are beat-

en and broken with the shovel or poker. The little slag which is produced is thrown up in the corner of the furnace, to be broken up and mixed with the ore, or reserved for the slag furnace. It is important neither for its quantity nor its richness, this method of smelting being found very effectual in reducing the ore. The metal soon fills the basin at the bottom of the fireplace and then runs out down the groove in the sloping hearth in front into a pot, where it is kept in a melted state by a fire of chips under the pot, and is ladled out into moulds whenever convenient. The whole inside of the fireplace, is lined with heavy blocks of cast iron made for the purpose, and generally brought down the Ohio river. Considerable skill is requisite in managing the fire, and it is only by long practice that one learns the true method of stirring up the charge, so that the metal shall run freely and steadily. The lime is supposed to act as a flux, but very little however is used, a handful or so being thrown on at each stirring.

The following are two estimates of the expense of working one of these furnaces. Being made at different furnaces, they will be seen to differ somewhat.

Expenses of blast furnace, two shifts.

Two smelters, $1 54 per day,	$3 8
Two back hands, 78 cts.,	1 56
Two assistants, 69 cts.,	1 38
Fuel, 20 bbls. charcoal, 12½ cts., wood, 50 cts.,	3 00
Board, six hands, 35 cts.,	2 10
Ore, 6000 lbs. $15,	90 00
Hauling ore,	3 00
Hauling 4,200 lbs. lead to Galena,	12 60
Daily expense,	$116 72

The hauling to Galena need not be more than 80 cts. per 100 lbs., $8 40 instead of $12 60, making a difference of $4 20. The charcoal may be made for less on one's own land, and one fifth of the price of the ore might be saved if the whole was mined on one's own land ; four fifths of the discovery too was the proprietors.

Product, 4,200 lbs. worth $126.—Slag worth ——.

Expenses of blast furnace, one shift.

One smelter, ...	$1 15
Two assistants, 57½ cts., ...	1 15
Fuel, 8 bbls. charcoal, 12½ cts., wood, 50 cts.,	1 50
Board, three hands, 50 cts.	1 50
Ore, 3000 lbs. $15, ...	45 00
Hauling ore nine miles to furnace, 75 cts. .	2 25
Hauling lead to Galena, 2,100 lbs., . .	4 20
Daily expense, ...	$56 75

One fifth ore rent saves $9. Hauling the ore and board may be much less. The wages as estimated, are lower than workmen can generally be employed for.

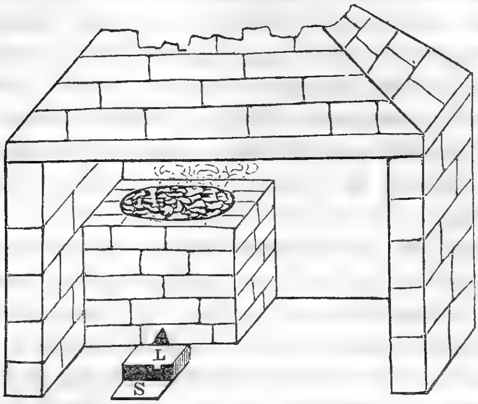
Product 2,100 lbs. worth $63.—Slag worth ——.

From both these estimates, it will be seen that the amount of lead obtained from the ore supplied is seventy per cent. Ten to twelve per cent. then is lost, and remains in the slag. The walls and front of the furnace are always covered with a thick incrustation of oxide and sulphate of lead, and much more goes off in the white smoke, all of which might be saved were it an object.

In estimating the importance of this business, it must be taken into account that it is not always an easy matter to keep *one* furnace supplied with ore, much more several. And on the other hand, that the returns for the sale of the lead are at the price it bears at Galena with the merchants there, who make their profits by shipping it to the eastern market.

The slag furnace, of which a drawing is given on the next page, (Fig. 3,) is often connected with a blast furnace or a reverberatory, particularly when the smelter can obtain any of the old slag from the now abandoned "ash furnaces" to mix with what he makes. At some furnaces the slag is beaten up under stampers and washed through a series of vats, but generally it is merely broken by hammer into small lumps, and then thrown into the furnace. The principle of the slag furnace differs from that of the blast furnace, in which the ore is exposed to the greatest oxidizing action to be obtained; the object being thoroughly to melt the slag and keep it in a fluid state until the metal separates itself, and both run out together through the hole in front. The lead sinks

Fig. 3.



Furnace about four feet high, four feet deep, and five feet front.
Tweer introduced from behind, opposite the hole for the exit of the lead and slag.
Fuel—charcoal.
L, vessel to catch the lead.
S, hole to catch the slag; in this runs a current of water.

into the first vessel, the slag floats over it into the next, through which runs a stream of water. Here it is cooled, and then ladled out and thrown away.* The amount of lead produced by one of these furnaces, varies of course with the quality of the slag. At O'Neill's slag furnace on the Peccatolica, near Mineral Point, where the charge consists of the rich reverberatory furnace slag, and that from the old ash furnaces, twenty seven pigs of lead are frequently obtained at one shift or day's work; twenty five, however, are considered a good day's work. The hands employed, are a smelter, back-hand, and assistant.

Having given this particular account of the furnaces, I will now enter into an examination of the lead business taken as a whole; and most of the data for the estimate I shall take from the report of Dr. Owen.

The whole number of furnaces in Iowa, Illinois, and the territory of Wisconsin, he judges to be fifty. This was in the year 1839, since which there has been no great variation in the busi-

* It is supposed this glassy slag is nearly free of metal; but having analyzed it by digesting in nitric acid, separating the silica, throwing down the lead as a sulphuret by hydrosulphuric acid, and converting this into sulphate of lead, I found it to contain 24.72 per cent. of oxide of lead.

ness. Four are in Iowa, and about as many in Illinois. About sixteen are reverberatory furnaces, the rest principally blast. These fifty furnaces make about 30,000,000 pounds of lead annually, which is 600,000 pounds to each on the average. But six of them are estimated to make 1,000,000 pounds each, and four from 1,260,000 to 1,502,200 pounds each, while seven make only from 400,000 to 194,610 pounds each, the least made by any one furnace.

He estimates the whole number of miners to be three thousand, but considers they do not work on the average more than half their time. From many examples of their success in mining, he says, "it would seem then to be a very low and safe estimate, to calculate each miner's daily work on the average at 150 pounds of ore. Now supposing that of the three thousand miners estimated to be at work in the district, one third are engaged in 'prospecting,' and other unproductive preparations, and only two thousand actually employed in raising ore, and that these two thousand work only one hundred and fifty days in each year, we have the following result. Each miner will raise annually 22,500 pounds of ore. The two thousand miners will raise annually 45,000,000 pounds of ore, and this at 70 per cent., which is rather below than above the average yield of the galena of this district, will give 31,500,000 pounds of lead as the annual produce of these mines."

So far goes the calculation of Dr. Owen; from it and from a number of instances of miners raising a large amount of ore in a short time, and of small tracts proving wonderfully productive, he draws a vague conclusion of the unbounded richness of this region, and of the profits to be derived from the business. But I propose to carry out these estimates and see the results.

Allowing that 45,000,000 pounds of ore is the annual yield of the mines, and dividing this according to customary shares between the miners and smelters, we must allow to the former 530 pounds of *lead* for every 1000 pounds of ore, for in this way they often take their pay for the ore, receiving from 520 to 540 pounds of *lead*. The mean 530 is equivalent to 757 of ore; it is divided then as by the following calculation.

757	
45,000,000	
3785,000	34,065,000
3028	70
34065,000 miners' share of ore.	23,845,500 lead.
	3
10935,000 smelters' share of ore.	
70	3000)715,365,00 value.
7,654,500	$238 45 each miner receives annually.
3	
50)229,635,00 value.	

$4,592 70 each smelter receives after paying for his ore.

To ascertain the other expenses of each furnace in making its share of the 31,500,000 lbs. of lead, we divide this amount by the number of furnaces, by the pounds to the pig, and the number of pigs that may be made in a day, to get the number of days, as $31,500,000 \div 50 \div 70 \div 60 = 150$.

The daily expenses, according to the two estimates of the blast furnaces, deducting the price of ore, is as follows :

$116 72	$113 50		
90 00	90 00	$4,592 70	$4,592 70
$26 72	$23 50	4,008 00	3,525 00
150	150	$584 70	$1,067 70
1,336 00	1,175 00		
2,672	2,350		
$4,008 00	$3,525 00		

By this estimate each furnace receives an annual profit of from $584 70 to $1,067 70, and this by 150 full days' work, with no allowance for the loss incurred by the remaining idle days ; and each miner receives annually $238 45.

As these are deductions from estimates given in a very glowing account of the lead business, the result is not likely to be too unfavorable of it taken as a whole ; and the conclusion must follow that the chances are against any one furnace doing a good

business, if conducted under the same circumstances that the average of them now are.

It is evident, however, that the manner in which the business is conducted is far from being perfect—that great savings may be effected by means of sufficient capital to be drawn upon when required; the miners being encouraged by it to keep up the supply of ore, and the furnace thus enabled to keep in blast, while also the power is afforded of buying up quantities of ore when it is at a low price. So lead itself may be advantageously bought sometimes of other smelters, or an advance made upon it in anticipation of its sale in the eastern market.

The possession of timber lands also would be no small saving in a district where wood is worth $5 per cord, as it is in the winter at Mineral Point, and where charcoal sells for the exorbitant price of twelve and a half cents per bushel.

The item of hauling may perhaps be somewhat diminished, but this is doubtful. The present method almost universally adopted is, to employ men who come with their own teams from Illinois and take loads from the furnaces to Galena, or, as is sometimes done, to Milwaukie. From Mineral Point to Galena, the common price is twenty cents per hundred pounds, distance forty miles. They use oxen and do not stop at taverns. The oxen for about six months in the year, pick up grass enough on the prairies where they stop in the day or to camp at night. If a man used his own teams and hired drivers, they would require, besides their wages, board at taverns. Though I believed at the time I first considered the subject, that by purchasing mules in Missouri, where they can be bought for from $25 to $40 each, and keeping one's own teams, the cost of transportation might be much lessened, I now think that unless the business would certainly keep them constantly employed, it would not be worth while to try the experiment, particularly should oats cost 37½ cts. per bushel, as they did in the summer of 1841, even after the harvest. Each working mule requires about twelve quarts a day, oxen none. Most of the smelters own several teams of horses, which are generally used for hauling ore. Mules no doubt might be advantageously substituted for them.

The freight from Galena to St. Louis varies in price according to the stage of the water. The charges are from 15 cts. to 30 cts. per 100 lbs. This difference may often make it an object to

delay the immediate sale or shipment of lead for a rise in the river, when one has capital to go on with in the mean time. From Galena to New York $1 25 is considered a fair estimate for the expenses of transportation per 100 lbs.; but it is said this amount may be diminished one third, besides the saving in time, if one goes on himself with a large amount.

Attention begins to be directed to the probability of the ports on the lakes becoming the shipping points for the Wisconsin lead. In this case those mines farthest east would be the most important; these are on Sugar Creek, and a reverberatory furnace has lately been put in operation there. No great confidence, however, is expressed by the miners generally in the continuance of the ores; I did not see them. They lie about one hundred miles west of Racine, the nearest port on Lake Michigan, to which runs the national road, finished to Rock river, on the direct way to the mines at Sugar Creek. This is one of the best roads in the territory; all the gullies are bridged over, and, excepting a few months in the wet season, is very passable. I have made the following estimate, from which some idea may be obtained of the expense of hauling lead across the country.

Estimated expenses of hauling lead one hundred miles east to Racine.

Four horses (or mules better) will haul two tons and come back in eight days, will eat a bushel of oats to a span of horses, or half a bushel to a span of mules, per day. Oats worth, at the most, in the eastern part of the territory 25 cts.

Whole amount of oats for four horses,		$4 00
Hay (if horses are put up at night) 32 nights, 12½,		4 00
Driver 50 cts. per day,		4 00
Board of driver, 75 cts. per day at most,		6 00
Wagon costs $75, horses $75 each, (mules $35,) eight days' interest at 10 per cent.,		1 00
Allow for wear and tear of wagon per year,	$25	
Shoeing four horses per year,	60	
Risk of horses per year,	40	For 8 days, 2 75
	$125	
		$21 75

Now between the lake and Rock river country, no little amount of transportation is constantly going on, and the *back* loads there-

fore would pay for a great part of the whole expense. The price for hauling store goods and pine lumber to Janesville, on Rock river, is 50 cents per cwt., equal to $20 per load of two tons. When it is remembered that all the pine used in the southern part of Wisconsin and northern part of Illinois in the neighborhood of Rock river, must be brought in from the lake, and that this is the best route; and when also the rapid increase of that most favored district, the Rock river country, is remembered, confidence may be felt that a line of teams would be almost supported by the back loads; and to secure one always, it might be an object to the owners to have a depot for lumber at Janesville. Pine boards are worth at Racine from $10 to $15 per thousand feet, or when carried to Rock river they sell for $25. For about two months in the spring and fall seasons, no hauling could be done for bad roads, and perhaps for two months more in the year thirty cwt. would make a load.

By inquiries made of those navigating the lakes, masters of steamboats and schooners, it is found that in common times, when the supply of wheat to be carried east is not in excess, they would contract to take lead to Buffalo and forward it by the canal to New York for $12 per ton—nearly 54 cts. per hundred pounds. That from Mineral Point to New York, was to Galena 20 cts., to New York $1 25=$1 45 per hundred pounds. This leaves 91 cts. per hundred pounds, or $20 38 per ton for the expenses to the lake, to make the amount of transportation equal to that by the way of New Orleans; but the estimated expense was $21 75. The difference and a large balance for any under estimate of the expense from the lake to New York, would be supplied by the back loads.

This subject is entitled to the more serious consideration, from the fact that the lead now used throughout the whole country bordering on the great lakes as well as in New York state, is carried from the mines near the Mississippi river to New Orleans, thence to New York, and by the canal to the lakes, thus making a circuit of nearly the whole Union. To supply shot alone immediately to this vast region, thus saving the expense it runs up for transportation, would seem to be a good business. Loads of it are occasionally now taken from the tower at Helena, on the Wisconsin river, across the country to Milwaukie, but more finds its way back to the territory, even after making the long tour to the south and east.

The great saving in time, too, would be an additional advantage of this route. It is open so early in the spring, that lead would get to New York as soon as from Galena, although it would be on its way first from the latter port.

A charter has been obtained for a canal to be constructed from Milwaukie to Rock river, by which a means of cheap transportation thus far would be afforded; but this is not likely to be soon completed. When it is, the Peccatolica will, no doubt, be cleared and opened for slack-water navigation, and boats will go from the vicinity of Mineral Point down that stream, and either up Rock river, and across to the lake, or down it to the Mississippi.

To treat of all the resources of this favored region, besides its lead and copper and iron ores, would demand the limits of a volume rather than an article for a scientific journal. Blessed with a delightful climate, rich soil, fine streams, its surface and natural growth admirably adapted for grazing, it promises soon to become the most important part of the great western country. Its inhabitants are industrious and enterprising, and the emigrants that are gradually filling the territory, are principally hard working farmers from the eastern states.

Near St. Louis, within six miles of it to the west and southwest, occur the bituminous coal measures; these are also found opposite the city in Illinois, on Muddy Creek to the south, and at various points up the river, as far as the mouth of Rock River; on leaving St. Louis and proceeding to the south one comes immediately to the great calcareous formation beneath them, that is here so productive in lead ore. Heavy beds of sandstone are interstratified with the limestone, and the formation in places partakes more of the arenaceous than calcareous character. The dip of these rocks varies with local causes, for the most part; they appear to lie horizontally. Ledges of granite and ranges of granite hills often intersect the limestone strata, running in a direction nearly north and south. They seldom seem to have affected the dip of the stratified rocks in contact with them, as is usually the case where they have been projected through them, and this would lead to the supposition that the limestone and sandstone had been deposited subsequently to the time when the granite was in its present position. But from the altered nature of the limestone, and from the fact of metallic veins, copper and

iron, being found at the point of contact, I am led to the opinion that the granite is the more recent rock, and that more veins may with confidence be looked for along and near its line of junction with the limestone.

Not only do sandstone beds alternate with the limestone, but in the vicinity of known lead mines, particularly, the limestone comprises heavy beds of a cavernous, siliceous rock, exceedingly hard, like the French burrstone, and like it sometimes suitable for millstones. There too abound in it mammillary and botryoidal masses of quartz rock coated with crystals, veins of calcareous spar, known by the name of "*tiff*," and lumps and beds of hematite iron ore, all which are now considered in Missouri indicative of the proximity of lead ore veins. These, unlike the copper ore veins noticed, occur at a distance from the granite, which agrees well with the position of lead and copper mines in Cornwall; tin and copper being there found near granite, and lead, antimony, manganese, iron, &c. at a distance from it.

The sandstone does not to my knowledge contain veins of ores; these are every where in the limestone, and in those places where the sandstone is the prevailing rock no mines are wrought. This rock is occasionally useful as a building stone, for furnaces particularly, and it sometimes occurs of a suitable quality for the manufacture of glass, as at a locality four miles east of Caledonia on the Farmington road.

The lead ore occurs in various ways, frequently in horizontal strata in the red clay overlying the rock; in true rock veins, which are subject to all the variations in thickness, in richness, and to all the changes that the better known veins in the primary rocks are; and also in vertical fissures in the limestone, either in loose "chunks" in the clay which fills these fissures, or in regular horizontal layers at intervals across them, or incrusting the walls of the fissures, accompanying them as far as they are followed. When the fissures open out into what appears to have been a large cave, now filled with clay and mineral, the ore incrusts each side of the roof and floor, while within is the clay and sometimes an empty space. These caves are often of large size, large enough to admit wheelbarrows or carts, and the incrustation of a foot or more of galena round their walls affords no small profit to the proprietors and miners.

After working through these large openings they are found to shut nearly up, leaving only a crack with a thread of ore, and this often leads on through unprofitable rock to a rich vein again, and to other chambers. The richest mine now wrought in Missouri—Valleé & Perry's, in the southern part of Jefferson County—is of this character. Shafts have been sunk into the hill one hundred and ten feet, and adits driven into the hillsides.

In general the workings are very superficial, much of the ore being raised from the clay diggings, which seldom extend to the depth of twenty feet. Here the ore is in a horizontal position in the clay, as I remarked, and lies in thin sheets of limited and varying width, seldom exceeding thirty feet, and they are probably always in or connected with one of these fissures so common in the limestone. Throughout the several counties which are occupied with this formation, the miner recognizes a proximity to the fissures by the abundance of the peculiar red clay, of the hematite iron ore, and of the botryoidal and mammillary masses of quartz rock, and the exact position of the fissure itself is often indicated to his experienced eye by a slight sinking of surface, and by an east and west or north and south line of bushes or small plants, which have deep striking roots, and choose a situation, where they can send them deep down into the clay. Still these guides are not always sure, for men used to the business often spend a year or more in "prospecting," that is, in sinking experimental shafts, or following a fissure in hopes of its yielding a rich return of ore, and all without success. But by continuing their work, if their means allow of it, they seldom fail of finally striking a "lead," the sale or working of which repays them for all their labor.

Waldron Mine.—This though now considered of little importance is a place where considerable copper ore has been raised. It lies a little east of the Iron Mountain ridge, five miles east of Caledonia. The diggings are on the side of a low hill, and appear to follow an old fissure extending northwest and southeast, nearly in a direct line, with some branching, over an extent of about fifteen rods in length. No rock is exposed any where in place; the loose pieces are of a compact quartz rock, of a similar character with that of the Iron Mountain ridge. Here it may be meeting the limestone, though none is exposed. The diggings are all superficial, and nothing is now to be seen of the contents

of the fissure, but heaps of the red ferruginous earth that was thrown out. In these are seen pieces of hematite iron ore and nodules of flint, with an occasional piece of green carbonate of copper. But the ore was carefully picked out and carried away when the mine was wrought. The greatest depth reached was about fifteen feet. The ore from what I could learn was principally gossan, with lumps of iron ore and green carbonate of copper intermixed, scattered through it. It was taken about two miles to the furnace on Big River, where is good water power, and there smelted. The land, though poor, is covered with an open growth of good sized oaks.

From these insufficient data no conclusion can be drawn as to the real value of such a mine. Actual experiment, by the sinking of shafts properly directed, alone can determine its importance. The lumps of ore that I was able to obtain were not very promising in their quality, but the existence of the gossan is of itself a favorable indication that more ore will be found on sinking deep for it.

The tract of land connected with the mine consists of about one hundred and eighty acres, and could be purchased for $5,000, and probably much less. But though the indications of ore are sufficient to authorize a thorough examination by those interested there in such operations, they could not of themselves warrant a purchase of the property by any persons not engaged in mining in that section of country.

Iron Mountain.—The "Iron Mountain" and "Pilot Knob," two hills composed principally of *oligist* or peroxide of iron, like the iron mountains of Gellvara in Sweden, lie about sixty miles southwest from the Mississippi River, separated from it by a very hilly country. The one is a low hill of about one hundred and fifty feet elevation above its base, and forms a part of the range of primary hills extending along the east side of Bellevue valley. It being low and its sides gently sloping, there is no rock exposed upon it or near it in place. The loose stones found in greatest abundance on the east, south and west sides, are altogether the heavy iron ore with but an occasional piece of quartz either loose or attached to the ore, and these are in so great quantity as to render it certain that this part of the ridge consists mainly of iron ore in the form of a huge vein in the primary rocks. The top being flat, and the north side not falling away

for a great distance, no pieces of ore nor rock are exposed above the soil, but according to reports they may be traced several miles in a northerly direction. The soil itself consists of fragments of iron ore, and most of it, if mixed with the large lumps, would work well in a blast furnace. The pieces scattered about vary in size; few are so heavy that a man could not lift one of them, and they are so numerous that they could long be depended upon for the supply of many blast furnaces, without the necessity of mining at all. Notwithstanding the sterility of the soil, the hill is covered with a good growth of oak, and these trees are sufficiently abundant throughout this section of country to supply all the necessary fuel for large works during many years. But there is no good water power within less than ten or twelve miles. Limestone suitable for flux may be found almost any where in the valleys, and also hematite iron ore of suitable quality to mix with the heavy ores, or better, to work alone. Notwithstanding the abundance and richness of the Iron Mountain ore, it yielding about seventy per cent. of iron, it seems to me improbable that it will soon become of any great importance, even if a company could have a clear title to it, which none is now likely soon to obtain. For it is a difficult ore to work in a blast furnace—it is likely to be contaminated with titanium or other metals, which would much increase the difficulty of working, as well as injure the iron; and bloomeries, even if a great number could be in operation, could not make iron so cheap as to compete with the coke and anthracite iron of Pennsylvania, and the Ohio River country. The distance from the river, and nature of the country between, are also serious objections. Besides, if it were desirable to engage in this business, there is sufficient hematite iron ore, which though it yield only from thirty to forty per cent. is a more profitable ore to work, and may be found in abundance, as I have reason to believe, near the river and near the bituminous coal mines on the other side of it. It is this ore that makes the celebrated Juniata iron, and when smelted with charcoal always makes the softest and toughest bar iron. It was discovered and wrought some time ago near Caledonia, and the Iron Mountain ore was hauled and mixed with it. The furnace was a small quarter stack, and if properly managed ought to have done a good business; but it is now abandoned, probably on account of injudicious management.

Pilot Knob.—This is a much larger hill than the Iron Mountain. It lies about six miles south of it, and seems to form the termination of that ridge to the south. All around rise high hills enclosing this, but none that appear to be a continuation of the ridge. This attains an elevation of about seven hundred feet above the valleys, and is quite steep and rocky. Iron ore more close grained and compact than that of the Iron Mountain, is found in loose pieces at the foot of the hill, and these continue to increase in number and size on ascending. Half way up solid ledges of iron ore and piles of ferruginous rock, resembling blocks of granite on a steep primary mountain, appear. Some of it is a ferruginous and siliceous conglomerate, black or red, and continually varying in its proportion of oxide of iron, from quartz rock to the hardest and most compact iron ore. Some of it is of a slaty structure, easily splitting like slate. At the top it is more massive, and the best ore. Here rises a rocky peak, looking like a rough granite crag, of about sixty feet perpendicular elevation, forming the summit or knob from which the hill takes its name. The surface of the rock is of a gray color, covered with moss, and it would not be distinguished by an indifferent observer from other primary rocks. Huge blocks lie below the perpendicular peak, and the solid ledge itself is exposed along the summit for nearly two hundred feet in length, and forty or fifty in breadth. Nearly all this is found to be the rich peroxide of iron, but a part of it is the ferruginous conglomerate into which it passes, and which perhaps in many other places would be considered workable iron ore. The sides of the hills are covered, when not too rocky, with a good growth of oak, and the valleys and hills around contain valuable forests of these trees, but there is no good water power near, and the country is very thinly settled, the soil being of indifferent quality, and the surface very rough.

Other veins of iron ore are said to occur in the hills around, but none of them are likely soon to become of any practical importance.

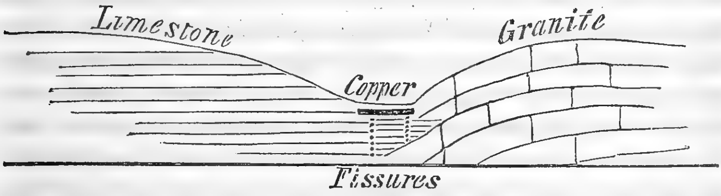
Some indications of *lead ore* are also found near the Iron Mountain range of hills, in Bellevue valley. One shaft, sunk by a Mr. Thomas, in a vertical east and west fissure, to the depth of forty four feet, afforded some galena, sulphurets of iron and copper, and carbonate of lead, sufficient only for specimens, but enough to encourage the proprietor to continue "prospecting" in hopes

to reach a vein that will make a show, and attract a purchaser. The fissure is in limestone, its greatest width about four feet, and has been traced east and west about fifty yards.

Mine La Motte.—This tract of country is about twenty miles east of the Iron Mountain, and is celebrated as containing some of the oldest and most profitable mines in Missouri. It consists of 24,010 acres of land, over different parts of which lead ore has been raised for more than one hundred years. The rock formation over the most of it is the sandstone and limestone, in horizontal strata. Through these, a rock resembling granite has forced its way, and forms ridges and ledges, which make up the remainder of the tract. It is a hard compact rock, composed of quartz and feldspar without mica, and usually of a red color. At its point of contact with the limestone are frequently found horizontal seams of ore, both copper and lead, and these are also found in many places where no rock at all is exposed for several feet down.

The following section shows the position of one of these copper ore veins as far as it has yet been followed.

Fig. 4.



The locality is called the Philadelphia mines. The ore is a carbonate, mixed with what I then took for black oxide of copper, and a considerable proportion of ochre. Until the specimens arrive, and I have an opportunity of carefully examining them, I cannot speak positively of their richness. What I mistook for black oxide of copper in a specimen I preserved from another locality in this tract, I have since found to be an oxide of cobalt and manganese, as will be seen farther on. And I now believe the black earthy mineral that forms a considerable part of the mass of some of the copper ores at the Philadelphia mine, to be the same oxide of cobalt and manganese. The ore is found in a bed consisting of clay with layers of slate and ore irregularly mixed. It is under a stratum of limestone which is very near

the granite beneath. The bed containing the ore is about two and a half feet average thickness; it varies much, however, both in thickness and in the relative quantity of ore, slate and clay. It has been traced along the line of contact of the granite and limestone in an east and west direction for about sixty yards, occupying about twenty yards in width, and always near the surface; the granite is on the south side, the limestone on the north. On the limestone side it has been followed some distance under the rock, and fissures are here found going vertically down and containing some ore in the loose clay that fills them, but their contents are not yet well developed. Attention is paid only to stripping the surface ores. Of these a large quantity was lying in piles near the diggings and at the wash places; estimated amount in rough ore and "sludge," (ore that has been broken and washed ready for the furnace,) about 200,000 pounds. But as it is only a short time that the ores have been wrought, four tons of copper is all that has been made from the whole mine, one ton of which was from the ore of this place. Carbonate of lead in white crystals accompanies this ore.

Two blast furnaces are built on a little stream near by, to smelt the ore, and connected with them are two of the common blast lead furnaces, the whole forming a stack of four furnaces. The water power is not constant, and for that reason they were not in blast when I saw them. There is no good water power on the whole tract. The furnaces are built of sandstone, which is found of tolerable quality and in abundance for the purpose. Oak wood is abundant, but the smelters pay seven cents a bushel for charcoal. The water wheel, eighteen feet in diameter, turns a fan, which keeps up a blast when the water is high, sufficient for the four furnaces. It is to be hoped that the explorations now going on will throw some further light upon the character, not only of these veins of copper ore, but through them upon all those contained in the limestone of this country.

Another deposit of copper ore, nearer the centre of the tract, is wrought by an English miner named Staley. The ore here lies under a great depth of clay and soil, in the deepest place about twenty four feet. A little scattering ore is found on going down to the thick stratum at the bottom; this the workmen say rests on limestone. It varies in thickness, but does not exceed eighteen inches; having been uncovered over an extent of a few

feet only, no one can judge how large a supply may be here obtained. The ore is considered richer than that from any other part of the mines, but I cannot speak positively of its qualities until I have had opportunity to examine the specimens.

Other places which are wrought for lead, furnish copper ore also, in greater or less quantities. At the "Deep Diggings," a light porous carbonate of copper is abundant, with carbonate of lead in white crystals intimately mixed with it, furnishing beautiful specimens. The gangue is a yellowish ferruginous earth, with layers of a black earthy matter running through it. This I found on examination to consist of oxide of cobalt and manganese, not a workable ore of cobalt, but rather a rare mineral, the cobalt of commerce being derived altogether from arsenical cobalt ores.

All these copper ores were, until within three years, considered worthless and troublesome to the workmen in their search for galena; so it was with the rich and easily smelted carbonate of lead, which was buried up in great quantities, and is now redug from out the old rubbish. The proprietors say that the workmen can afford to sell the copper ores prepared for the furnace for less than twenty dollars per thousand weight, and forty dollars per ton.

Owing to the miserable system in which their mining operations are conducted, no attempts have been made to prove the real importance of these ores, and no estimate can be made of their probable duration. The whole estate is owned by a few "proprietors," who do not work the mines themselves, but receive from any one who chooses to work them, one tenth of the produce. The proprietors may as individuals work also on the same terms. A certain lot is marked out to each miner, (most of whom are common farmers from the adjacent country,) and he goes to work after his own ideas of mining, so as to get out the most available ores with as little expense as possible. He has no desire to discover permanent veins, and no care for the welfare of the whole mine, since his interests cannot continue longer than about six years from this time, when the whole falls back again to the sole possession of the proprietors. Thus two hundred men are employed in skimming off the surface ores; one set throwing their rubbish over unwrought tracts, which another set will remove again another year to get at the ore below. Most of the workings are open to the day, and no search is made for

any other ore than that which runs in horizontal strata through the clay or through the rock near the surface. In one instance, however, the limestone rock itself contains so much galena scattered through it, as to render it an object to be quarried, beaten up, washed and smelted. Notwithstanding this rude way of mining—the same hands taking the lead ore through all the different operations of raising, washing, and smelting—they still find the business so prosperous that two hundred men employ themselves on the tract. In their progress they occasionally meet with vertical fissures filled with clay, and more or less ore scattered through them; one miner, more enterprising than the rest, followed one of these fissures down about seventy feet, and then abandoned it, the water coming in.

Some of the lead ores here have been considered argentiferous, but on examining the most promising, a fine steel-grained crystalline galena, by cupelling, I can find no silver; indeed it is only among the lead ores found in the primary rocks that one is led to look for this metal.

There are now nine blast furnaces on this tract, and will be five more in a few months; besides these there are two cupolas and one air or reverberatory furnace. The blast furnaces are driven by four steam engines and one water wheel. The steam engines are of fifteen horse-power each; these are now owned by different individuals, but in six or seven years from this time will belong to the land. Much of the land is suitable for farming, the soil being good and surface gently rolling, but no inducements have been held out to any persons to cultivate it, and with one exception, all the houses on the tract are of the most miserable kind of log cabins plastered with mud. No wells are dug, and little attention paid by any of the people to supply themselves with the common comforts of life.

A certificate published by an agent of the company in 1837, states that for the four preceding years the annual amount of lead manufactured may be estimated at 1,035,820 pounds, of which one tenth came to the proprietors as rent, and that the number of persons employed may be estimated as one hundred and fifty, each of whom receives therefore 69,005 pounds; and the following remarks of the proprietors accompany the certificate.

"Supposing the lead to be worth five cents the pound, we have the sum of $345 for each hand. When we take into considera-

tion the manner in which the hands work, the amount of labor lost by that manner, and the time which they willingly throw away, we cannot fail to be impressed with the belief that no business promises a greater yield from the employment of labor than is offered at the La Motte mines. We close our remarks, confident that the wealth of these mines is as yet scarce known."

As to lead being worth five cents, it may be remembered that it seldom sells in St. Louis for more than four.

Current River.—Between the region just described and the Current river, the country is rough and uninhabited, except by a few half farmers, half hunters, who live with as little labor as is necessary just to support themselves and families.

The rocks are sandstone and limestone, and a quartzose rock into which the sandstone seems to pass on going south, and veins or beds of which fill a large part of the limestone strata. The high hills which one crosses near the heads of Big Black river, and between it and the Current, consist almost universally of this quartzose rock, with the limestone strata just appearing beneath it in the ravines. The roads over the hills are made up of sharp flinty nodules, and these also form the greater part of the surface of the country, rendering it totally unsuitable for cultivation. Some few pieces of lead ore are occasionally found loose in the ravines and valleys. The ridges are of great height and often very steep, forming between the streams narrow "hog-backs," which widen beyond into broad table lands of eight hundred or one thousand feet elevation above the streams below. There are long valleys, too, extending nearly north and south, of no great width, which on either side give place to ground gently rising into the hills beyond, and which appear from their connexion one with another, from their occasionally winding and again spreading out into broad flats like bays, as though they might have been the bed of a large stream long ago left dry. The growth is principally oak and pitch-pine trees of good size, and abundant. Along the banks of the streams are many buttonwood trees of enormous size; sugar-maple too are plenty there, but they do not grow on the hills. The streams are remarkably clear, their bottoms consisting of rolled fragments of quartz, flint, chalcedony, and jasper, and the water runs very quickly over them.

On the Current and Jack's Fork, (a branch of it,) the banks are generally precipitous, the limestone forming steep bluffs of great height, above which, in the hill-tops, the quartzose rock is often seen cropping out. This limestone is of a light gray color, with a crystalline texture, and lies in nearly horizontal strata. The rock is full of quartz veins, which run generally with the stratification, and should rather therefore be called beds of quartz. They are intimately mixed with the limestone, so that it appears sometimes to pass into quartz rock, the two not being easily distinguished, and sometimes the quartz predominates over the limestone in relative proportion. Little nests and bunches of quartz crystals frequently occur, both in the quartz beds and in the limestone. Excepting these, and the calcareous spar in veins, and pearl spar, no minerals were observed. Stains of a greenish hue, like those of carbonate of copper, may be noticed almost every where, on and through pieces of the limestone. I found no fossil shells in the limestone; in the siliceous rock above, a few imperfect encrinites were met with.

A range of igneous rock—a red compact siliceous rock, close grain, flinty fracture, porphyritic near the limestone, crosses Jack's Fork in a direction west of north, east of south, about five miles above its confluence with the Current. A mile or two above this ridge, the limestone is seen dipping about 10° W. S. W., and a mile below, the dip is about as much E. N. E. The ridge formed by this range of igneous rock is about three hundred feet at the highest elevation above the river; it has been traced, it is said, in a north course ten or twelve miles, and it or similar parallel ridges of red rock extend across the line into Arkansas. It crosses Jack's Fork in town XXIX, range 4. In town XXIX, range 3, farther north in the township, another ridge of red rock is to be seen, which will be more particularly noticed when describing "Valleé's diggings."

At the contact of the first range with the limestone on the south side of Jack's Fork, five miles up it, and a mile back, is a deposit of copper ore in the soil, principally a green carbonate, but the black oxide (?) with a little sulphuret forms a considerable part of the whole. This has been dug over to the extent of about three fourths of an acre since 1839, when it was discovered. The diggings extended to the depth of about ten feet average, the deepest hole being eighteen feet; but concerning this I

could get no satisfactory information, no work being now done there. The mine is in a dilapidated condition, and little insight can be obtained as to the true position of the ore. The limestone and red rock meet each other very confusedly, there being near the surface no regular line of contact. Fissures or openings extend vertically down between the rocks, and these are filled with a mixture of iron ore, copper ore, clay and gossan, while above, the surface is composed of gravel, consisting of pebbles of quartz, chalcedony, and jasper mixed with red and yellowish clay. The work over this small tract, which alone was found to contain the ore, was carried on very badly. Instead of the whole surface being stripped off clean to the rock, little holes and trenches were dug all over it, and where the loose ore was found most abundant, there the most digging was done. Sometimes the copper ore forms nearly the whole material from the surface down even to the depth of seven feet, the greatest thickness yet found to consist almost entirely of ore. It lies in irregular shaped masses, accompanied with hematite iron ore, into which it passes, and these masses vary from pebbles up to the weight of seventy pounds. They are scattered through the clay and gossan, or lie sometimes in contact, and sometimes tending to a horizontal position. The clay and gossan are found to be worth washing for the ore they contain. A little spot about twenty feet square, where the ore was most abundant, is said to have produced as much as all the rest. Little veins of copper ore, principally carbonate, may be seen running through the limestone, where it comes to the surface, the thickest not more than half an inch thick; and on the granite under the other ores is often found a thin plate of oxide of copper, incrusting the rock but not joined to it. The grain of the limestone is here irregular, the seams of stratification obliterated, and it is impossible to determine the amount of disturbance it has experienced. Veins of "tiff" (calc spar) are occasionally found in it, and with them small fragments of oxide of copper interspersed, and crystals of pearl spar and pargasite (?)

A rotten vein, a foot thick, at about the point of contact of the two rocks, consists of a curious altered mixture of them, with particles of carbonate of copper scattered through the mass. This sort of breccia is considered of some importance, as indicating the proximity of ore, for almost exactly similar specimens

were found at two other localities to be described. By following this rotten vein, the true lodes will most likely be discovered, if such exist, as there is reason to believe is the case. The loose ore is now pretty much all worked out, and no vein of any importance taking to the rock has been discovered. No attempts to find one by sinking a shaft through the limestone near the granite have been made, though there can be no doubt that the indications and the suitable ground for metallic veins warrant the undertaking. The soil is wet, and from the broken character of the rocks, the water is likely to be troublesome. The locality, however, is on a hillside at the head of a hollow, and all the surface water may be conducted down it. It faces north; on the west side is the red rock ridge, on the east is the limestone ridge; and the little creek marks about the line of junction of the two rocks. A similar little brook has been noticed in a similar position in the two other localities.

The furnace is about a mile from the diggings, on a little stream called Shawnee's Creek, which comes into Jack's Fork not far above its mouth. There the ore is all hauled, beaten up by hand and washed, the gravel and mud washed three or four times, and the workmen receive for it when clean $27 per thousand, gross weight. Some of them found it so profitable at that, as to purchase the right of digging of other workmen; one even agreed to pay $100 for the right to work only about a rod square. The furnace is about three feet high inside and a foot square. It can run only about a week at a time before the whole inside must be pulled out and built up anew, there being no good stone for lining a furnace in the country.

It is several months since the furnace was in operation, and the workmen could give me little account of it. No flux is used except the old slag, which is beaten up and thrown in. The fine ore has not been smelted, owing to the blast blowing it all out of the furnace. This is accumulating, and several tons are ready for smelting, when a proper furnace shall have been constructed. It is built of quartz rock and lined with the same, and was originally much larger and gradually diminished to its present internal capacity. A common overshot wheel, twelve feet in diameter, moves a large blacksmith's bellows, and this is all the machinery about the furnace. The fuel is pitch pine charcoal, which may be obtained in any quantity from government lands for

the expense of cutting and burning. Oak, elm, buttonwood, hickory, maple, cedar, cherry, &c. are plenty. The oak is principally white oak and post oak; locust and mulberry trees grow wild, and the latter bear good fruit.

As to the nature of the ore, its origin, by a right idea of which some judgment may be formed of its probable continuance, it seems that the crevices or fissures which the workmen describe as occurring in their diggings have served as passage ways through which the ore has been projected from below, either in a melted state or in a state of sublimation, or by more slowly acting electrical causes; and that near the surface on the line of fissures, (which is likely to be nearly the line of contact of the two rocks,) the ore has found favorable circumstances to spread and deposit itself; and further, that these same circumstances may be expected to be renewed at different depths, and the ore there found in lateral injections between the limestone strata, in veins and in the main fissures themselves. Veins of calc spar are of frequent occurrence in these rocks, and one in particular was discovered some years since in the red rock not far from the present copper diggings, of uncommon thickness. These also accompany the better developed copper ore veins in the primary rocks on Lake Superior and in other parts of the world; and Dr. Houghton has remarked of them, that they pass into veins of copper ore, and veins of copper ore may be traced through different changes till they become veins of calc spar.

Copper ore as well as lead ore is obtained to some extent in this formation in England. The deepest mine in that country is the Eaton copper mine in Staffordshire, the shaft being four hundred and seventy two yards deep in the mountain limestone.

One of the other localities to which I have referred, as containing indications of veins of copper ore, is on the other side of Jack's Fork, connected with this same red rock ridge, not two miles from the old diggings. The limestone and the red rock are both well exposed, excepting just at the point of contact; they both manifest the same variety of changes as they approach each other that they do at the old diggings—the same porphyritic appearance of the quartz rock, the same breccia that there filled the rotten vein is here noticed, and small pieces of carbonate of copper have been dug up from a hole only four feet deep. But there seems no probability of here finding a large deposit of surface ore.

The third locality is that known as "Valleé's diggings," M. Nereé Valleé, of St. Louis, having spent some time in working there, and owning a large share of the mine. It is on the north side of the Current river, not quite a mile from it, and about seven miles N. N. E. from the old diggings on Jack's Fork. Here too the ore is found at the junction of the red rock and the limestone, on the edge of a little run which had washed out loose pieces of the ore, thus leading to the discovery. All that can be determined of the quality of the ore here is, that there is a seam about four inches thick running horizontally under limestone strata into the hill; what its extent is no one can tell, nor whether it leads to any rich veins. The ore is of a different quality from that at the old diggings, being more of a sulphuret, and this mixed with the blue carbonate as well as the green. It much resembles the ore from Mineral Point, Wisconsin. The red rock belongs to a different ridge from that at the old diggings, being farther east. In character, however, and in the changes the rock undergoes near the limestone, they are the same. Valleé became tired of the country and the business, and quitted both. He did considerable work here, but too injudiciously to determine any thing concerning the capabilities of the mine.

These repetitions of the ore encourage the prospect of this becoming a copper mining country, and naturally lead the people there to look for other veins of ore, which to some extent they have been successful in finding. I have seen ore said to have been discovered near the Current, not far from the Arkansas line, and also from Fourche à Dumas, a stream in that same part of the country. Many discoveries are also reported to have been made by individuals, who think it prudent to keep them secret, now that the government lands are not subject to entry. These localities and others, no doubt, might be discovered by a party of a few men kept at work exploring. But though this may turn out to be a copper mining country, there are many things now operating greatly to its disadvantage. The lands are not yet in the market; the titles to the mines are founded on old Spanish claims, and on the right of preëmption. These are in contest between two parties as regards the old diggings, and their dispute is not likely to be soon settled. Then, whichever party is successful, the mines will be valued at an exorbitant rate, as though they were already proved to be rich and permanent. Then,

too, their remoteness is a serious objection; they are one hundred and forty miles by road from Cape Girardeau on the Mississippi river. The country between is unsettled and poor, and little communication is had across it. All the supplies of weight and bulk must come up the Current river, so that all kinds of store goods are of high price and not easily obtained.

The hills in the neighborhood can never pay for cultivation. It is only the narrow strips along the sides of the large streams that are fertile; these, however, may be made to support a considerable population. The climate is exceedingly unfavorable to enterprise, six months of the year at least being hot and oppressive, if not unhealthy; if the people become accustomed to it, they also become very indolent in their habits, and a laborer there accomplishes in a day about half as much as in other parts of the United States. Still the price of labor for the most common hands, is up to from $12 to $25 per month and found, and a regular miner receives from $20 to $30. There are few slaves in this section of the country. In regular mining, it is considered preferable to pay so much for the ore raised than to give wages, no confidence ever being reposed in the faithfulness of agents. And this is another serious objection—the liability to encounter difficulties with the hands, they being generally of unsettled habits, and all possessing a most independent spirit, that hardly permits them to work for others at all, and causes them to quit for the slightest cause, particularly when the lands around them shall be subject to entry, and they can for a few dollars purchase a farm of their own. Selling the ore is to them, therefore, the most satisfactory way of proceeding, while the mine itself is left to suffer from bad management and want of thorough explorations. The provisions required by the people are of the cheapest kind—corn and bacon, coffee and sugar, being nearly all they need. Corn may be bought at prices varying from twenty five to fifty cents a bushel, and bacon at about eight cents a pound; the other articles at about double their value in a civilized country. Horses are suffered to take care of themselves; they will fatten in the woods after the 10th of April; an abundance of wild hay might be cut if wanted. But few of the settlers keep a supply of hay, fodder or oats; all, however, are well supplied with corn. Cattle can do very well in the woods, and with little expense could be raised in great numbers; so of

hogs. But the wolves and a sickness peculiar to the sheep here, will prevent their being raised to any extent.

It is a good country for water power, fine springs, ever flowing and never freezing, bursting out on the hillsides, and sometimes affording power enough for any works at their very source. Some of these are described as curiosities, such as are seldom met with elsewhere. Connected with these springs by similar causes, are the phenomena of sinking creeks, natural tunnels through the hills, and vast caves hardly explored as yet, all due to the tendency of the limestone to be worn and hollowed out by the action of water. The river being supplied by these springs, and running quick, never freezes over; but it is only at intervals, except in the spring months, that it is up so that rafts can run. When they do go they are carried down very rapidly, but there are no dangerous rapids; boats are sometimes dashed against the cliffs in the sharp turns of the river, which are frequent. Steamboats have come up within eighty miles of the Forks, (Jack's Fork and the Current,) and it is thought that if there were an object, they might come to the Forks in the spring months and during the winter.

There are about ten mills, principally saw-mills, along the Current and its branches, north of the Arkansaw line. Rafts of pitch pine are sent down every year in great numbers. The boards bring from $15 to $20 per thousand feet, but they may be bought for $10 at the mills. They are put together to the amount of six in thickness, and so run nine miles below the state line, when the rafts are doubled.

The copper that was made was sent down on large flat boats, which were constructed for the purpose, and could carry from twenty to thirty tons each. About seventy five tons altogether were made on the Current and thus shipped for New Orleans.

The statistical account of the expenses of making lead, which I had no means in Missouri, as before mentioned, of obtaining, cannot differ essentially from the account given of the Wisconsin furnaces. There is this difference, however, in the price of the "mineral" or lead ore, that when it is sold by the miners in Wisconsin for from $15 to $16 per thousand pounds, it brings them in Missouri about $18 for the same quantity. Lead is worth about half a cent more a pound in St. Louis than it is at Galena.

ART. V.—*Observations on Photographic processes;* by WILLIAM F. CHANNING.

IN the photographic preparations of silver, the agency of light is confined to a change in the arrangement of the particles, or to a partial decomposition. As in galvanic decomposition, it is assisted by coinciding chemical affinities, and these may be brought to act on the salt of silver either in the preparation before exposure to light, or afterwards to bring out the impression. In the Daguerreotype, mercury seems to act mechanically in making apparent the molecular change wrought in the iodide of silver by the action of light. In the recent photographic processes of Talbot, however, a chemical agent is used subsequently to complete the decomposition which light had begun.

A sensitive preparation of silver is one in which "the elements are so delicately balanced as to be overturned by the slightest cause."* The fulminating compounds of silver are examples of such a composition and may form hereafter preparations very sensitive to light. None of the more simple salts of silver are immediately reduced by light, though it may afterwards be made apparent by chemical means that they have undergone a change of structure or that a subsalt has been formed. Thus chloride of silver is apparently insensible to light, unless, for example, organic matter containing carbon, oxygen and hydrogen be associated with it, when the affinity of the carbon for the oxygen, and of the hydrogen for the chlorine, immediately determines a reduction. Thus carbon reduces the oxide of silver in many of its oxy-salts. Electro-positive bodies therefore, which are associated with the salt of silver, tend directly or indirectly to decompose it by removing the electro-negative principle combined with the silver, while an excess of electro-negative elements, oxygen, chlorine, &c. as in the perchlorate, chlorate and hypochlorate of silver, retards decomposition. Thus compounds such as phosphorus, tannic, gallic, crenic, fulminic acids, which may be called deoxidizing agents, all absorbing oxygen, and also another series acting mechanically, such as mercury, deserve attention, first in making a photographic preparation, and second, in bringing out

* Hunt—Griffin's Scientific Miscellany.

an impression after the action of light. There are singular reactions, however, constantly observed in photographic chemistry, which cannot be comprehended or explained by any general statement.

In a recent process of Hunt,* a paper is first prepared with iodide of silver and then washed with ferrocyanide of potassium and used moist. The ferrocyanide contains carbon, potassium, iron and nitrogen without oxygen. Mixed in powder with substances abounding in oxygen, such as nitrate or chlorate of potash, it explodes by heat or percussion. In this case it is easy to see that if water were present a slight cause would determine its oxygen to the ferrocyanide and its hydrogen to the iodine of the silver. Water in the form of water of crystallization, hygrometric moisture, or artificially applied, often thus performs an important part in these preparations. The cyanide of potassium is equally or more efficacious than the ferrocyanide. Besides the inconvenience of using a moist paper, this is not so sensitive as Talbot's calotype paper,† founded on his important discovery of the properties of gallic acid.

For this the paper is washed successively with nitrate of silver and iodide of potassium; then before using with a mixture of acetic acid, nitrate of silver, and gallic acid, which must be made at the time. After a short exposure in the camera, the paper, still apparently unchanged, is washed again with the above mixture, when the impression begins to grow upon the paper in a very striking and beautiful manner. The objection to this process is its complication. The following is a very simple modification of it, nearly as sensitive, and more so than the original Daguerreotype plates.

A piece of best glazed letter paper is fastened by means of a penknife point and some hard wood pegs to a piece of smooth pine board. It is washed over once quickly and evenly by means of a camel's hair brush, with a solution of sixty grains crystallized nitrate of silver in one ounce of water. Let it dry spontaneously, and as soon as dry wash it for a minute with a brush and solution of ten grains of iodide of potassium in one ounce of water. Then instantly wash it with water by dipping it three

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* Report of the British Association, 1841.

† London and Ed. Phil. Mag., Aug. 1841.

or four times in a suitable vessel and dry it by pressing it gently between blotting paper. It is then ready for the camera. One minute is sufficient for a building on which a February sun is shining, four or five minutes for general views. A rather more sensitive paper is prepared by using a mixed solution of five grains of iodide of potassium and five grains of chloride of sodium in one ounce of water instead of the iodide of potassium. Five grains of bromide of potassium in one ounce of water forms a rather less sensitive preparation. These papers may also be made more sensitive by washing them again, after the iodide of potassium, with nitrate of silver, though it will hardly repay the labor. The series of salts of silver, according to their sensibility, when afterwards brought out by gallic acid, appears to be iodide with chloride, iodide, iodide with bromide, bromide, bromide with chloride, chloride, fluoride nitrate; ferrocyanide, sulphocyanide, cyanide. The series with mercury differs essentially from this.

After exposure these papers are still white, but they need only to be fastened as before to another piece of board, and washed over once quickly and evenly with a saturated solution of crystallized gallic acid (only three or four grains in one ounce of water) or with solution of galls, to bring out in a few moments the hidden impression. A weak impression may be brought out by several washings, letting the paper dry between each. Too long an exposure however in the camera is better than too short an one. When it has come out sufficiently, dip it in water and fix it by washing it with the iodide or other solution used in the preparation. Then wash it in water and dry between blotting paper as before.

In views from which copies are to be taken by superposition over other sensitive paper, it is better perhaps to use the bromide throughout, as it leaves the paper whiter and more permeable to the chemical rays, or to fix the paper prepared with iodide by washing with a bromide solution or hyposulphite of soda. Care must be taken in making a proof not to use the nitrate of silver or galls too profusely, otherwise the paper will be stained through. Papers merely washed with nitrate of silver, used as soon as dry, and brought out afterwards by galls, may answer well for copies.

These papers should not be exposed to light or heat during any part of the process, and there should be no delay between the use of the nitrate of silver and iodide of potassium; for the nitrate

on paper is soon decomposed, so that gallic acid discolors it. The iodized paper will keep a long while, unless there is much excess of nitrate of silver. It is best, however, to use it soon after it is made.

It is important to the sensibility of all these preparations, that the nitrate of silver solution should be neutral, have no excess of acid, the electro-negative ingredient; and also that there should be no excess of iodide of potassium, another electro-negative element, on the paper, but rather the reverse. The brushes used should be made without metal, and no metal should touch the paper during its preparation. All the parts of the operation should be kept distinct to ensure a perfect result.

The analogy in these processes to the Daguerreotype is very interesting, iodide of silver being brought out in both cases after the action of light. Though the Daguerreotype cannot be brought out by gallic acid, yet Balard noticed a year ago* that the vapor of mercury would bring out an impression on prepared paper. It is curious to hold one half of a piece of iodized paper, which has received an impression over mercury heated in a capsule, and wash the other half with gallic acid. The first brings out a faint negative sketch, the last a strong negative picture. By preparing a black carbonaceous paper with iodide of silver, the vapor of mercury brings out a sort of positive picture which may deserve some attention.

The solution of galls seems to furnish much that is wanted in a secondary reducing agent. Still the field is open for inquiry. A solution of common tea, from its tannic acid, brings out an impression imperfectly well. Crenic acid, or a solution of peat, which also abstracts oxygen during its decomposition, seems also to have this property.

There is no science which is now advancing so rapidly as photography. These processes will soon undoubtedly be superseded; they may, however, be of interest and use at the present moment.

Boston, February 28, 1842.

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* Comptes Rendus, February, 1841.

Art. VI.—*On the Principle of Virtual Velocities;* by Prof. Theodore Strong.*

We shall premise the following definitions and principles.

Def. 1. Whatever moves or tends to move any portion of matter, is called force; and the point at which the force is applied is called its point of application.

Def. 2. Our idea of force requires us to consider its action as being in a right line which passes through its point of application; this line is called the line of the force's action; and by the direction of the force we mean the direction of that part of this line (reckoned from the point of application) into which the force moves or tends to move the body to which it is applied.

If we represent any given (or assumed) force by unity, then if any other forces contain the unit of force P, Q, &c. times, these forces will be expressed (by the numbers) P, Q, &c. If a body is acted on by two forces in the same direction, their resultant is expressed by their sum, and acts in the same direction as the forces; but if the forces act in opposite directions, the resultant will equal the difference of the forces, and acts in the direction of the greater force.

Investigation of the principle.—Let a body or a system of bodies (or material points) be affected by the forces P, Q, R, &c. in such a manner as to be in equilibrium. Imagine points regarded as fixed to be taken in the lines in which the forces act, such that the forces shall at the same time each tend to increase or decrease the distance of its point of application from the point taken in the line of its action, (the positions of the points in other respects being arbitrary;) we shall call the fixed point which is taken in the line of action of any force (for simplicity) the centre of that force.

Let p, q, r, &c. denote the distances of the points of application of P, Q, R, &c. from their respective centres; then if we denote the sum of the products Pp, Qq, &c. (which are each evidently

* Prof. Silliman—*Dear Sir:* As some objections have been made to the first part of my paper on Virtual Velocities, (see this Journal, Vol. xlii, p. 66,) I have concluded to re-write the part which has been objected to, and to enter more fully into detail in several respects than in that article, for the purpose of clearness and explanation. Yours, &c. T. Strong.
New Brunswick, Jan. 25, 1842.

positive) by M, we get $Pp+Qq+Rr+\&c.=M$, (1). Since the forces balance each other, it is manifest that their action will not alter any of the distances p, q, r, &c.

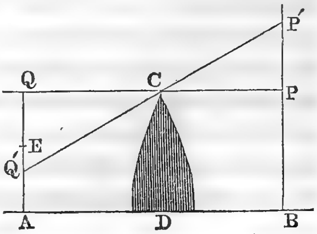
Again, we may evidently conceive the points of application of the forces in their several lines of action to be changed, provided each new point of application is considered as firmly connected with the point to which the corresponding force was at first applied.

Hence if we suppose the points of application of P, Q, &c. to be changed, and denote the new values of p, q, &c. by p', q', &c. (the centres of the several forces remaining unchanged,) and the new value of M by M', (1) will be changed to $Pp'+Qq'+\&c.=M'$, (2). It is also manifest that there are an indefinite number of ways in which p', q', &c. may be taken (without affecting any one of the forces P, Q, &c.) so that we shall have $M'=M$, or $Pp'+Qq'+\&c.=Pp+Qq+\&c.$ (3). If we use Δ, (the characteristic of finite differences,) when prefixed to any quantity, to denote any finite increment or decrement of the quantity, which is to be considered as positive when the quantity is increased, and negative when it is decreased, we shall have $p'-p=\Delta p$, $q'-q=\Delta q$, and so on; hence (3) is easily changed to $P\Delta p+Q\Delta q+\&c.=0$, (4), which ought to be satisfied independently of any arbitrary quantities which may be introduced by Δp, Δq, &c.; that is, the coefficient of each arbitrary independent quantity thus introduced must be put $=0$; as is evident from the consideration that P, Q, &c. do not affect p, q, &c., p', q', &c.; $\therefore$ they do not affect Δp, Δq, &c.

We shall use δ, (the characteristic of variations,) when prefixed to any quantity to denote any indefinitely small variation of the quantity, the variation being considered as positive when the quantity is increased, and negative when it is decreased. The forces being supposed to be in equilibrium, let the position of the body or system be very slightly changed, (but in a manner consistent with its conditions, or with the connections of its parts in the case of a system;) and that in consequence of the change of position, p, q, &c., P, Q, &c. become $p+\delta p$, $q+\delta q$, &c., $P+\delta P$, $Q+\delta Q$, &c.; also that M becomes $M+\delta M$, then (1) will be changed to $(P+\delta P).(p+\delta p)+(Q+\delta Q).(q+\delta q)+\&c.=M+\delta M$, (4). It is manifest that $p+\delta p$, $q+\delta q$, &c. are equal to their projections on p, q, &c. (in (1),) when quantities of the orders $(\delta p)^2$, $(\delta q)^2$, $(\delta p)^3$, &c. are rejected, also by rejecting quantities of the

same orders of minuteness $P+\delta P$, $Q+\delta Q$, &c. may be supposed to act in p, q, &c.; hence the forces $P+\delta P$, $Q+\delta Q$, &c. in (4) may be supposed to act in p, q, &c., the distances of their points of application from the centres being $p+\delta p$, $q+\delta q$, &c. Again, δP, δQ, &c. may be supposed to act at the same points and in the same lines as P, Q, &c. in (1), ∴ by changing P, Q, &c. into $P+\delta P$, $Q+\delta Q$, &c. without changing p, q, &c., also using $M+\delta M'$ to denote what M becomes, (1) will become $(P+\delta P)p+(Q+\delta Q)q+\&c.=M+\delta M'$, (5). Now the forces P, Q, &c. in (5), which are the same as in (1), balance each other; also the forces δP, δQ, &c. in (5) will balance each other when quantities of the order $\delta P\,.\,\delta p$, $\delta Q\,.\,\delta q$, &c. are rejected, which ought to be done on account of the supposed minuteness of δP, δQ, &c. Now the forces in (4) and (5) are the same, and act in the same lines and directions (when quantities of the orders $(\delta p)^2$, $(\delta q)^2$, $\delta P\,.\,\delta p$, &c. are rejected,) the points of application of $P+\delta P$, $Q+\delta Q$, &c. in (4) being at the distances $p+\delta p$, $q+\delta q$, &c. from their centres, and at the distances p, q, &c. in (5) from the same centres; but the forces in (5) are in equilibrium, ∴ they ought (by what has been shown before) to be in equilibrium in (4), supposing the corresponding points of application of each force in (4) and (5) to be firmly connected; hence we may equate the first members of (4) and (5), and indeed we ought to equate them to indicate that the forces are the same; hence we have $(P+\delta P)\,.\,(p+\delta p)+(Q+\delta Q)\,.\,(q+\delta q)+\&c.=(P+\delta P)p+(Q+\delta Q)q+\&c.$, or by reduction $(P+\delta P)\delta p+(Q+\delta Q)\delta q+\&c.=0$; or rejecting quantities of the order $\delta P\,.\,\delta p$, $\delta Q\,.\,\delta q$, &c. we have $P\delta p+Q\delta q+\&c.=0$, (6), which is the equation of virtual velocities as required. It may be remarked, that in applying (6), we must put the coefficient of any independent variation which may be introduced by the variations δp, δq, &c.$=0$, since δp, δq, &c. are independent of P, Q, &c.

Application.—Let QCP be a straight lever, whose fulcrum is C; P and Q the weight and power, which tend to descend in the parallel lines PB, QA, which are perpendicular to the horizontal plane AB; and suppose that P and Q balance each other, to determine the relation of P and Q, supposing CP and QC to be given?



The forces at P and Q will be expressed by P and Q, then by taking B and A for the centres of P and Q, we shall have p=PB, q=QA, and we shall get $Pp+Qq=P\times PB+Q\times QA$. Again, let the points of application of P and Q be changed from P and Q to P′ and E, these points being taken in the lines PB, QA, (produced if required,) and such that if we denote P′B by p', and AE by q', we shall have as in (3) $Pp+Qq=Pp'+Qq'$, or $(p'-p)P=(q-q')Q$, or $P\times P'P=Q\times EQ$, (a). Join CP′ and produce it to intersect QA in Q′, then the triangles CPP′, QCQ′ being similar, we get $QQ'=\frac{CQ}{CP}\times PP'$, $\therefore QE=QQ'-Q'E=\frac{CQ}{CP}\times PP'-Q'E$, which substituted in ($a$) we get $P\times P'P=Q\times\frac{CQ}{CP}\times P'P-Q\times Q'E$, ($b$). Now since P′P is arbitrary, we must equate its coefficients, $\therefore P=Q\times\frac{CQ}{CP}$, or $P\times CP=Q\times CQ$, which gives the well known law of equilibrium in the lever: in order to satisfy (b), we must also put $Q'E=0$; which shows that to satisfy the conditions in (3), the point E ought to have been taken at Q′, where CP′ produced intersects QA.

In a similar way we can easily find the pressure on the fulcrum C, (which is the resultant of P and Q,) and did room permit, we could easily deduce the well known principle of the parallelogram of forces.

Art. VII.—*A dangerous Property of Wood Ashes exposed, and some of their other Properties examined;* by Dr. John T. Plummer, of Richmond, Indiana.

TO THE EDITORS OF THE AMERICAN JOURNAL OF SCIENCE.

I have recently devoted some time to a further examination into the properties of wood ashes, and especially into that property by which heat is conveyed from a small space on their surface deeply into the interior of the largest masses. I consider the subject of sufficient importance to claim the attention of the general as well as the scientific reader; for I cannot forbear thinking, that at least some of the mysterious conflagrations which are repeatedly occurring, are chargeable to this hitherto unsuspected cause.

Judging by the remarks of Prof. Hubbard, accompanying two cases of combustion in wood ashes, reported by him in a late number of this Journal,* it appears to be his opinion that the caloric in question was generated within and near the bottom of the heap, by a spontaneous but unknown process. I conceive that the following experiments render this opinion highly improbable, and they go to sustain the view taken by the present writer, so far as it respects the origin of the caloric, and perhaps measurably as it regards the means by which the heat is diffused throughout the ashes. They show that the heat-retaining power is not peculiar to ashes, but is common to various pulverulent substances; that this residue of combustion contains an appreciable quantity of charcoal in a state of minute division; and, as formerly stated, that it is unsafe to deposit hot ashes upon, perhaps, the largest heaps of cold ashes. I shall marshall these experiments under the head of

Ignitibility of Wood Ashes.—1. A pint of sifted ashes was made into a conical heap four inches high, upon a folded newspaper, and a coal lighted at one corner only, was laid upon the summit and very slightly covered. In seventeen minutes the coal was examined and found to be wholly ignited. It was again covered, and in eleven minutes afterward, that part of the paper on which the ashes rested became quite warm, and also the board beneath it. On sliding the paper nearly off the board, and gently bending it convexly upwards, I succeeded in producing a fissure, extending from the apex of the cone downward to a considerable depth. By this means I was enabled to see the interior of my diminutive volcano, and to discover that the ashes within were *red hot*, if not incandescent, as far down as the fissure extended. After this peep, I closed up the crater by sliding the paper back upon the board, and waited an hour from the beginning of the experiment. At the expiration of this period, the coal was not wholly consumed, and the ashes were still quite warm.

The coal used in the foregoing instance was of sugar-tree wood, and at the time it was placed upon the ashes, two other coals, one of sugar-tree and the other of beech, were thoroughly ignited and

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* Vol. XLII, p. 165, *et seq.*

laid upon a board. In two minutes the "fire went out" of both these coals.

2. A wooden pill-box of the largest size was filled with sifted ashes, and an oak coal weighing seven grains was barely buried in them. In thirty five minutes the box was very warm all over; and at this time I surrounded it with cold ashes. In twenty minutes more, the ashes within and immediately around the box were uncomfortably hot.

3. I renewed the second experiment, with the exception of not wholly covering the box. The edge was left exposed, to ascertain whether it would not act as a vent to the accumulating caloric. In half an hour I examined the coal, and found it extinct and the ashes cold. The coal in this case was of beech.

4. This beech coal lighted at one corner, was placed on a cone of sifted ashes, as in the first experiment, and in twenty minutes it was thoroughly ignited. I now pressed a cylinder of pasteboard perpendicularly into the ashes, so as to include the coal and most of the heated ashes. The upper edge of the cylinder was left uncovered. I did not examine the coal for an hour; it was at that time not consumed but dead, and the ashes were entirely cold.

5. I built a cone of a quart of pale ashes, and deposited eight or ten dead coals some distance apart, near the base and remote from the surface; at the apex I buried a live coal as before. In three quarters of an hour, stiff paper or a splinter of wood thrust into the centre of the heap took fire; and on demolishing the pile, I found that the heat had descended to the coals below, and ignited them; indeed they were partially consumed, and the whole interior of the base of the cone was extremely hot.

6. A wooden box ten inches deep and eleven inches square, was filled with unsifted ashes as cold as an exposure of several weeks in winter could make them. A pint of hot ashes was thrown upon the middle of the surface and left uncovered. In eight hours all the central portion of the ashes was hot enough to fire wood thrust into it, and two sides of the box were incalescent. In twenty three hours, the bottom of the box was quite warm, the top of the ashes cool, and the sides of the box were becoming cool. A stick plunged to the bottom of the ashes, was drawn out ignited or burnt at the end, but not even charred above it. In thirty hours the bottom of the box was almost insupport-

ably hot; and the upper half of the ashes retained but little heat. In thirty six hours, the temperature of the ashes being much reduced, I emptied the box, and found the bottom of it on the inside near the middle converted to coal, one of the sides considerably charred, and another browned by the heat. Coals were found in different parts of the ashes, but I believe they were confined to those portions through which the heat did not travel.

The ashes used in the foregoing and the subsequent experiments, were derived from the mixed combustion of hickory, beech, sugar-tree, oak, and a few other kinds of wood; and the sieve employed consisted of twenty four by thirty two interstices to the square inch.

To what cause could I attribute the augmentation of heat and its downward course, which the preceding instances exhibit? The plausible answer was, carbon. There, said the spirit of conjecture, was the fire, burning its way into the ashes, and leaving successive portions of them to cool after it had consumed the combustible matter out of them; travelling downward, like the Goth's descent upon Rome, into regions where its fierceness could be fed. There, too, was the *gray* color of the ashes, produced, said conjecture, by the admixture of fine carbonaceous particles with the pure white cineritious matter. To prove that the proper color of wood ashes is white, there lay the beautiful specimen with gossamer lightness upon the hearth, the residue of the undisturbed combustion of a solitary ember; showing the delicate fibrous structure of the original wood; with open avenues on every side, and a thousand apertures within for the free admission of atmospheric oxygen to every atom of carbon; the carbon thus affianced to oxygen had escaped into the air, leaving its white mansion unshaded by its presence. And how could I better account for the various shades of gray which ashes present, than by supposing them to arise from the various proportions of the black powder intermixed? And then, there were the uniform results of repeated trials by fire, in which something escaped out of the contents of the crucible; and what could this be but carbon? Such was the language of imagination before experiment had fully uttered its voice. To strengthen these conclusions, I applied myself to other evidences; but these, to my disappointment, instead of supporting, kicked against my imaginings.

7. Selecting magnesia as an article possessing physical properties somewhat similar to those of ashes, I erected a cone of this material, and at the summit buried a partially ignited coal. In a few minutes I was surprised to find the whole coal was alive with fire. Shortly afterwards the magnesia beneath the coal became ignited, and the bottom of the heap almost intolerably hot.

8. Guided by the specific gravity and the compressibility of the substances employed, I repeated the experiment with pulverized chalk instead of magnesia. The chalk soon became red hot, beneath the coal; and the base of the heap, heated beyond endurance.

Thus discovering that these alkaline earths possessed the same heat-preserving properties as ashes, and that the same downward, centralizing tendency of caloric was shown in all, I was led to the conclusion that the heat eliminated and diffused in the sifted ashes was the result of the combustion of the single coal buried in them; and considering their low conducting and radiating power, it appeared probable that the amount of heat apparent was not very far from the absolute quantity generated during the combustion. In every instance, while the central parts of the cones were red hot, the exterior of the ashes except at the apex was cold throughout the experiment. The caloric is evolved faster than it is diffused, and of course it accumulates within a small sphere near the coal to an igniting temperature; combustible matter lying at the circumference of this sphere, would ignite and generate another ball of fire, and this produce another, and so on indefinitely, or while the last ignited spheres reached new combustible matter. In this manner I conceive the caloric travelled in the fifth and sixth experiments, and I see no reason why it should not under similar circumstances circulate through a bed of ashes spread over the whole earth.

Satisfying myself in this manner that the presence of pulverulent charcoal was not essential to the phenomenon in question, I submitted other powders to similar trials.

9. Fine sand, scorified wood ashes, anhydrous sulphate of lime, common earth, all thoroughly dried, and the earth and sulphate reduced to subtle powders, were severally made the tenements of a fully ignited coal; but in spite of all the persuasion I could command, the coal refused to be buried alive in such sepulchres as these; almost as soon as it was decently interred, it expired.

During my inquiries into this subject, I was induced to compare the physical and other properties of various powders. Omitting my tables of their specific gravity, porosity, &c. as incomplete, I give the other results below. The substances were dried at a high temperature, and passed through the same sieve; the force used in ascertaining the compressibility was sixty pounds.

The *gravity* was determined by weighing a given measure, without compression or jar.

Water, being	1000
Magnesia, was	164
Ashes, ...	356
Chalk, ...	582
Scorified wood ashes, ...	910
Plaster of Paris, ...	921
Common earth, ...	1035
Sand, ...	1358

Compressibility.

The loose measure, being . . .	100
Ashes were reduced in bulk, to . .	25
Magnesia, ...	50
Chalk, ...	50
Plaster of Paris, ...	69
Common earth, ...	69
Scorified ashes, ...	86
Sand, ...	88

The sand could be shaken into a less space than it could be pressed by the force employed.

Conductibility.—I selected neat paper pill-boxes of uniform size, color, &c. and filled them evenly and without jarring, with the several powders tested. On the centre of the surface, I carefully placed very small squares of tin-foil supporting a particle of phosphorus. Thus prepared, the boxes were at the same instant carefully set upon an equally heated metallic plate, and the time of fusion and of deflagration noted. I give, in the subjoined table, the average results of several trials, in seconds.

Magnesia.	Ashes.	Scorif. ashes.	Chalk.	Sand.	Coal.	Earth.	Gypsum.	Sugar.
42.335	112.267	125.242.	123 293	125.242	77.420	182.300	154.314	218.407

When fused, the phosphorus assumed a hemispherical form, and delicate vivid lines shot like lightning from the margin ap-

parently across the semiglobule, and continued thus to play in the most lively manner from various points in rapid succession until inflammation ensued. This pretty miniature pyrotechny can only be seen in the dark.

*Hygrometric Power of Wood Ashes.**—One hundred grains of dried ashes were lightly spread over an area of sixty square inches, and were exposed with due caution in the shade for twenty four hours, when the noon temperature was 62°, and the air clear and calm. In this time they gained no weight; continued exposure for seventy two hours enabled them to gain .55 of a grain. But when the temperature was near the freezing point at noon, they frequently gained in eight to twenty four hours from .66 to 1.66 of a grain. A fine sponge was converted into a sensitive hygrometer by saturating it with a solution of carbonate of potash, and drying it at 170°. Thus prepared the sponge gained from thirteen to forty four per cent. more than the ashes, and it assisted me in making out the following deductions from eighteen experiments on the hygrometric properties of ashes. 1. They absorb atmospheric vapor more rapidly at a low than at a high temperature. 2. They do not cease to act hygrometrically at a temperature considerably below the freezing point. 3. The range of per centage of increase is from 0 to 1.66. 4. Different parcels of ashes possess different degrees of hygrometric power. This is owing perhaps to the varying quantity of potash present.

Carbonaceous Dust in Ashes.—It became interesting to ascertain how much, if any carbon, in a pulverized state, existed in ashes. For this purpose I employed sundry rather rude methods, now to be mentioned. 1. By pouring a sufficient quantity of sulphuric acid on sifted ashes, to moisten them, much caloric was disengaged, and a white paste formed, in which black particles were very obvious. These particles washed and crushed between the teeth, produced the peculiar sensation of breaking charcoal. On diluting this paste with a large quantity of water, a milky mixture (sulphate of lime) was obtained, in which the black particles rapidly subsided. All the black sediment, however, was not coal. 2. One thousand grains of sifted ashes were

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* Your note appended to a former communication from me, requires that I should say now what I ought to have said while penning that communication, that hygrometric dampness *was* expelled from the ashes in the experiment referred to.

stirred in a large quantity of water, and allowed to subside. In a short time the insoluble parts settled at the bottom, and most of the coal with them, very few particles of it floating on the water. Hence the porosity of the coal must have been sufficiently destroyed to render the fragments specifically heavier than this fluid. 3. The washed ashes used in the foregoing experiments, were examined by a microscope, and particles of coal clearly seen in them. Specimens of well burnt and sifted ashes from the stove, exhibited the same appearance. 4. Several hundred grains of sifted ashes were treated with nitric acid, and after long digestion, the residue was washed, dried, and weighed; the quantity was six per cent. of the original weight of the ashes. Under the microscope this residue was found to consist of particles of coal, a greater proportion of black vitrified grains, and transparent particles which scratched glass, and appeared to have undergone partial fusion. 5. One hundred grains of sifted ashes were in like manner submitted to the action of hydrochloric acid. On diluting the solution with water, a black matter was immediately deposited with gray particles beneath it. The black sediment, washed and dried, assumed a black-brown color, and weighed a fraction over six grains. This powder scintillated in the blaze of a candle like coal-dust; under the action of the blowpipe it became gray, but the principal part remained unconsumed.

Having by these means convinced myself of the presence of coal-dust in ashes, it followed that an ordinary fire did not always consume all the carbon of wood; and to arrive at an approximation to the degree of heat necessary to burn it out of ashes, I tried the next experiments. 6. Sifted ashes were pressed firmly into a crucible, and to expel moisture I subjected them to a temperature of at least 440° for an hour. The temperature was ascertained by the fusion of tin. The ashes were then weighed, and subjected to a red heat for half an hour. On weighing again, there was no appreciable loss. Sulphuric acid and the microscope detected, as before, particles of coal in these *crucibulated* ashes. 7. Most of the ashes of the last experiment were placed loosely in the crucible, and again heated to redness for half an hour. The result was as before—no loss of weight. 8. Intimately mixing thirteen grains of coal-dust with four hundred and sixty seven grains of the crucibulated ashes of the seventh experiment, and pressing them together, they were heated to red-

ness for a considerable time. In this case there could be no doubt of the presence of carbon; yet after cooling, the mixture weighed just four hundred and eighty grains, and consequently had suffered no ponderable loss. 9. I now placed the crucible as it came from the furnace in the eighth experiment in a smith's forge, and heated it to incandescence for several minutes. At this heat the ashes lost nine grains, leaving at least four grains of the adventitious carbon unconsumed. 10. Four hundred and eighty grains of sifted ashes, hot from the stove, were put into the crucible, and exposed to the highest heat of a smith's forge for twenty minutes. On cooling, they weighed only four hundred and thirty one grains, having sustained a loss of forty nine grains! The ashes in the middle of the surface were gray, but all other parts throughout were bluish brown, or blackish and brown. The mass was porous, considerably contracted, and cracked through the centre nearly to the bottom of the crucible; it crumbled under considerable pressure, but retained its form in water, yielding up its soluble parts without falling to pieces. Throughout the slag were scattered grains of a beautiful cerulean hue, insoluble in nitric or sulphuric acid, and exhibiting under the microscope a botryoidal surface. These grains were evidently the product of the intense heat of the forge; and if we can suppose a sufficient quantity of alumine present in the ashes, what forbids them being *Hauyne* of domestic manufacture?

During this last crucibulation, care was taken, as before, to prevent the escape of ashes; the crucible was kept erect and well covered with a steel plate, and every precaution used to avoid error. Add to this vigilance, the fact that the ashes did not occupy more than one third the depth of the crucible, and we can hardly conceive that reverberating currents of air from the bellows, could dissipate any of the ashes. But to determine whether the loss was attributable to such an accident, or to the loose state of the ashes, I tried experiment 11. Seven hundred and twenty nine grains of hot, sifted ashes, were pressed into the crucible, and carefully heated in the forge for fifteen minutes. The loss was seventy grains, or 9.6+ per cent. The ashes were scorified, and presented the *hauynoid* grains and every other appearance and property of the slag of the tenth experiment. If no ashes escaped, how shall we account for the loss of weight? Is there a ponderable element in ashes, which has eluded former analy-

ses? Or did the intense heat of the forge decompose some of the constituents of ashes, drive off the gaseous elements, evaporate water of composition, and volatilize any of the solids? Regarding the known constituents of ashes, I ascertained that in one specimen of the scorified ashes there was a trace of caustic lime; I detected it in no other portion of the slag. Water in which the scorified ashes had digested several days, produced a very faint white cloud, on the addition of oxalate of ammonia. Another portion of the water boiled down, exhibited a lively effervescence on the addition of an acid. The slag from the crucible, though exposed to a damp atmosphere for several days, showed no disposition to deliquesce. The long digested and thoroughly washed scorified ashes, produced abundant effervescence with nitric acid; the resulting nitrate had the peculiar bitterness of that salt of lime, and produced a very copious white precipitate with oxalate of ammonia. I judge, therefore, that but a very small quantity of carbonic acid was driven off from the carbonates of lime and of potash; not more perhaps than would be counterbalanced by the oxidation of the iron contained in ashes. The presence of silica, iron, and a sulphate, were satisfactorily shown; an accident prevented me from testing the presence of a phosphate or a chloride. It therefore remains with me a moot question, what occasioned the loss in the tenth and eleventh experiments?

Since the publication of my former communication on this subject, I have received information of other accidents similar to those reported to this Journal, where large quantities of stored ashes had become extensively heated, and sometimes the wooden repository inflamed. In several instances it was known that hot ashes had been thrown upon the heap, under the impression that there was as much safety in doing so, as in depositing them upon the ground remote from combustible matter. What part the small portion of *pulverulent* coal may perform in the propagation of the fire, I am not prepared to say. That coal in some degree of comminution is necessary to the passage of caloric from one part of the mass to another I am convinced; and that charcoal in some state of division exists in most wood ashes, is easily proved by the use of a coarse sieve, to say nothing of the large coals generally apparent, and especially as they float upon the water of the leach-tub. It may here be asked, if this combustible material is thus distributed through the ashes, why does not

the fire always diffuse itself equally in the heap, instead of pursuing a devious path through it? What contingencies may direct its course, I do not know; but nothing more happens here than happens to a piece of paper inflamed at its edge; it seldom consumes equally, but the combustion proceeds in very uncertain directions.

Art. VIII.—*Caricography;* by Prof. C. Dewey.

(Appendix, continued from Vol. xxxix, p. 53.)

No. 173. Carex *Meadii*, D.

Tab. Cc. fig. 94.

Spicis distinctis; staminifera unica ovato-oblonga parvi-bracteata cum squama oblonga obtusa margine fusca; pistilliferis binis ovato-cylindraceis superne substaminiferis tristigmaticis pedunculatis sublaxifloris, inferiore longo-pedunculatis basi vaginatis; fructibus obovatis subrotundis obtusis nervosis perbrevi-rostratis et retrocurvis, squamam late-ovatam acutam vel obtusam et brevi-mucronata superantibus.

Culm eight to sixteen inches high, erect, leafy towards the base, glabrous, slightly scabrous above; leaves shorter below, linear-lanceolate, flat, smooth, pale green; staminate spike oblong, large, with an oblong obtuse scale tawny on the margin; pistillate spikes two, sometimes one, oblong, round, rather loose flowered, sometimes staminate at the apex, upper short-pedunculate, lower quite long-pedunculate, and both with leafy bracts sheathing at the base; fruit rather loose, obovate, obtuse, nerved, with a very short beak recurved at apex, and orifice closed; pistillate scale ovate, broad, acute, or short mucronate, reddish on the edge and green on the heel; pale green.

This Carex has a remote resemblance to C. *panicea*, and C. *binervis;* differs in several particulars, as well as from C. *polymorpha.* Found by Dr. S. B. Mead at Augusta, Ill.

No. 174. C. *Sartwellii*, D.

Tab. Cc. fig. 95.

Spica composita; spiculis 12–20 ovatis sessilibus subarctis bracteatis distigmaticis inferne pistilliferis, superioribus sæpe presertim staminiferis et inferioribus præcipue fructiferis, vel omnibus

pistilliferis; fructibus ovatis lanceolatis convexo-concavis subulatis subbidentatis, squama acuta ovata paulo longioribus.

Culm fifteen to twenty eight inches high, erect, leafy towards the base, three-sided, striate, scabrous; leaves flat, linear, striate, shorter than the culm, shorter below, and sheathing; spike two inches long and composed of numerous spikelets, fifteen to twenty each, ovate and sessile, simple pistillate below, sometimes with few staminate flowers, sometimes several of the upper spikelets mostly or entirely staminate, the lower half commonly more abundantly pistillate, sometimes all mostly pistillate; stigmas two; staminate scale lanceolate; scale of the fruit ovate, acute, rather broad, and a little shorter than the fruit; light green, stiff plant.

This Carex is near C. *intermedia*, Gooden.; but it differs from it in not having compound and compressed spikelets, and in having smaller fruit, and pistillate scale much shorter and less broad. From C. *marcida*, Boott, it differs in the lower spikelets, and in fruit, which is much shorter and less lanceolate.

Found by Dr. S. P. Sartwell in Junius, Seneca county, N. Y., after whom it is named, with the "genitive termination," and "in accordance with well established rules of botanical nomenclature."

No. 175. C. *macrocephala*, Willd. Tab. Cc. fig. 96.

Dioica; spica pistillifera composita maxima dense ovato-capitata distigmatica inferne substaminifera; fructibus ovato-lanceolatis maximis compressis nervosis glabris bicuspidatis margine serrulatis, squama ovata longo-cuspidata paulo longioribus.

Culm eight to twelve inches high, angular, large, leafy; leaves sheathing, numerous, flat, linear-lanceolate, longer than the culm, lower leaves short; staminate spike large and thick; diœcious, and stigmas two; fertile spike single, large, ovate, oblong, and composed of many small spikelets compacted into a dense head, sometimes staminate below; fruit large and long lanceolate; plant yellowish green.

This is a very singular and strongly marked species, supposed to inhabit Siberia by Sprengel in Systema Vegetabilium, Ed. 16; Dr. Boott credits it the Northwest coast, and Mr. Nuttall collected it in his tour across the Rocky Mountains, and through the kindness of Prof. Torrey I have been permitted to examine it.

No. 176. C. *Nuttallii*, D. Tab. Cc. fig. 97.

Spica composita; spiculis 5–8 ovatis sessilibus bracteatis distigmaticis superne staminiferis in capitulum denso-aggregatis; fructibus ovatis brevi-lanceolatis concavo-convexis ore integris, squama ovata lanceolata duplo longioribus.

Culm three to six inches high, erect, smooth, obtusely triangular; leaves flat, lanceolate, longer than the culm, with lower leaves shorter, and all sheathing; spike short, dense, five to eight spikelets closely aggregated, bracteate, and the lower with a leafy bract longer than the culm; fruit ovate, short-lanceolate, smooth; stigmas two; pistillate scale broad ovate, lanceolate, and twice as long as the fruit, membranaceous on the margin; color light green.

Collected by Mr. Nuttall on the Rocky Mountains, and named in honor of that distinguished and indefatigable botanist.

NOTE. C. *cephalophora*, Muh. Vol. X, p. 268. Var. *maxima*, D.

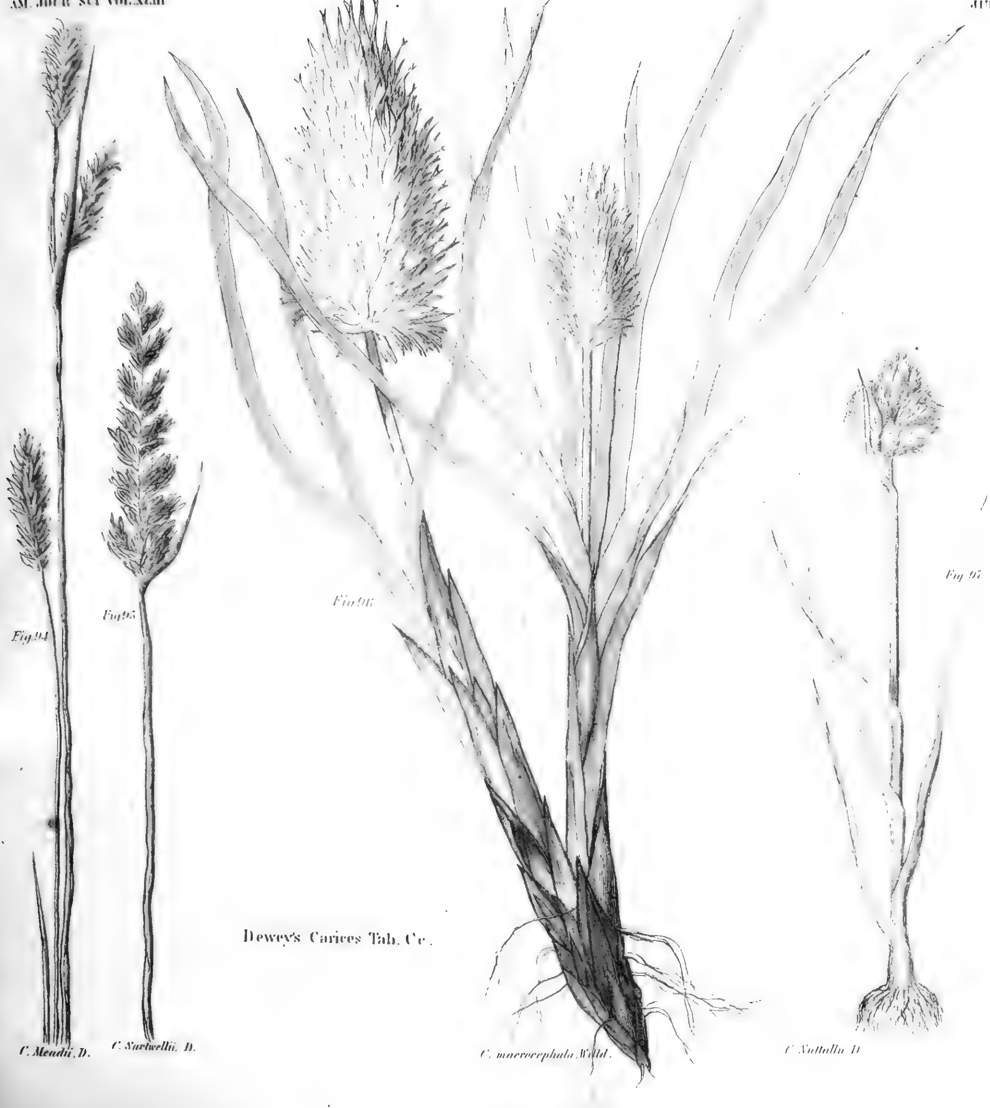
Spica composita; spicis 8–10 ovatis subaggregatis bracteatis flavescentibus; culmo triquetro striato 2-pedali basin foliato; squama ovata cuspidata.

Culm large, erect, acutely triquetrous, leafy towards the base; spikelets forming a loose spike an inch long, with diverging fruit; two stigmas; fruit ovate, lanceolate, winged, scabrous, two-toothed, and its scale about half as long as the fruit, with a cuspidate point extending to the end of the fruit; light green; woods.

The figure in Schk. has only a remote resemblance to this variety, which is so like some varieties of C. *stipata* in general appearance. The spike of this variety is four times as large as that drawn by Schk., who had it from eight to eighteen inches high. This variety grows in woods from two to four feet in height. I have specimens from four to twenty eight inches high. In the herbarium of Muhlenberg one specimen of the large C. *cephaloidea* is placed with this species. The smaller variety, corresponding to the figure of Schk., I have described in this Journal. This variety, so large and fine, was found by Dr. Sartwell, at Penn Yan, N. Y., and had been confounded, except by him, with C. *stipata*, which, however, always grows on wet grounds.

Figures of the following species accompany this paper:

$\left.\begin{array}{l}\text{C. } \textit{Meadii}\text{, D. Tab. Cc. fig. 94.}\\ \text{C. } \textit{Sartwellii}\text{, D. fig. 95.}\\ \text{C. } \textit{macrocephala}\text{, Willd. fig. 96.}\\ \text{C. } \textit{Nuttallii}\text{, D. fig. 97.}\end{array}\right\}\text{See Plate II.}$



Dewey's Carices Tab. Ce.

Fig. 94 — C. Meadii. D.

Fig. 95 — C. Sartwellii. D.

Fig. 96 — C. macrocephala. Willd.

Fig. 97 — C. Nuttallii. D.

Art. IX.—*On the Dip and Variation of the Magnetic Needle in the United States;* by Elias Loomis, Professor of Mathematics and Natural Philosophy in Western Reserve College.

[Communicated to the Connecticut Acad. of Arts and Sciences, April 28, 1842.]

I. *Dip of the Magnetic Needle.*

I propose in the present article to discuss all the observations of magnetic dip in the United States, which have come to my knowledge. Most of these have been given in former numbers of this Journal, and others will be found embodied in the tables which follow. In presenting this enquiry, it is important accurately to determine the annual change of dip. Unfortunately, the materials for this purpose are quite too scanty, and the results very discordant. The earliest observations of the kind I have met with, were made by Prof. Williams, at Cambridge, Mass. 1780–83, and published in the Memoirs of the American Academy, Vol. I, p. 68. According to this authority, the dip in 1783 was 69° 41′. In 1839, I found it to be 74° 20′.1, indicating an increase of five minutes per year. This result might be received as worthy of confidence, were it not that a remark of Prof. Williams throws a suspicion over the accuracy of his observations. He says: "the dip is subject to rather greater diurnal alterations than the variation; but they do not seem to be so regular in their changes. The least dip I have ever observed, was 68° 21′; the greatest, 70° 56′." According to observations at Milan, the diurnal change of dip is somewhat above one minute in summer, and about half a minute in winter. The diurnal change of the variation is, for this latitude, in summer, nearly fifteen minutes. The apparent diurnal motion observed by Prof. Williams must then have been due to the inaccuracy of his observations. The entire range of his observations he reports at 2° 35′. Now I regard it quite certain, that if the above numbers were obtained by observations in all the different positions of the needle as at present practiced, then his instrument was utterly worthless. The probability is that the necessary reversals were entirely neglected, and as no mention is made of reversing the poles of the needle, the presumption is that it was not attended to. In this case, the observations would be charged with a constant error whose

amount we have no means of estimating. In order to obtain more light upon this subject, I addressed a letter to Prof. Farrar, of Cambridge. In his answer he remarks: "I have every reason to believe that the only dipping needle belonging to the apparatus of the college, at the time of Prof. Williams' observations, was one made by Nairne, and is not, I think, to be depended upon. When I have attempted to use it, I have found the needle to rest in positions differing *several degrees* from each other." This last remark corresponds very well with the observations of Prof. Williams. If the original manuscript containing the observations can be found, it is possible that the suspicion which now attaches to them may be removed. At present, however, I place no confidence in them.

The next dip observations in point of age, are those made during Long's expedition to the Rocky Mountains in 1819. The dip at St. Louis, June 16, 1819, is given 70° 30′. I found the dip, Sept. 29, 1841, to be 69° 25′.5, shewing a decrease of about three minutes per year. The dip at Shippingsport is given 70° 15′. Prof. Locke found the dip at Louisville in 1840, 70° 4′, shewing a diminution of half a minute per year. The discordance of these results excites a suspicion of inaccuracy somewhere. A more satisfactory result may be expected by combining all the observations made in 1819, so as to obtain the mean dip at some one station. By this method we may be expected to eliminate in a measure the influence of local attraction, and also accidental errors of observation. The following table presents a summary of these observations, treated in the manner described in a former number of this Journal, Vol. XL, p. 85. As the observations are all comprised within a moderate period, I have not applied any correction to reduce them all to a common instant. Adopting for the central position latitude 39° 3′ N., longitude 91° 37′ W., we obtain the annexed equations of condition.

	Latitude.	Longitude.	Dip, 1819.	Equations of condition.	Diff.	Diff.
Shippingsport,	38° 15′ N.	85° 30′ W.	70° 15′	$1.250=\delta-48x+283.2y$	−13′.8	−14′.6
Merrimack river,	38 26	89 36	70 0	$1.000=\delta-37x+94.8y$	− 0.1	+ 7.9
St. Louis,	38 36	89 36	70 30	$1.500=\delta-27x+94.6y$	+24.0	+30.2
Cote sans Dessein,	38 36	91 56	70 50	$1.833=\delta-27x-14.9y$	+63.9	
Belle Fontaine,	38 43	89 36	70 0	$1.000=\delta-20x+94.4y$	−10.1	− 5.3
St. Charles,	38 46	89 48	70 5	$1.083=\delta-17x+85.0y$	− 5.2	− 0.4
Franklin,	38 57	92 57	69 30	$0.500=\delta-6x-62.2y$	−19.9	− 8.9
Camp,	39 7	94 0	69 45	$0.750=\delta+4x-110.9y$	− 2.0	+ 9.9
Charaton,	39 10	92 20	69 50	$0.833=\delta+7x-33.3y$	−12.9	− 5.9
Fort Osage,	39 10	94 18	69 18	$0.300=\delta+7x-124.8y$	−28.3	−16.1
Cow Island,	39 25	94 0	69 50	$0.833=\delta+22x-110.5y$	− 7.7	+ 0.8
Eng. Cantonment,	41 25	95 44	71 7.5	$2.125=\delta+142x-185.2y$	+12.3	+ 2.4

These equations solved by the method of minimum squares give $\delta=1.0801$, $x=+0.00987$, $y=+0.00303$, and the direction of the isoclinal lines is from N. 72° 56′ W. to S. 72° 56′ E. Computing from these data the dip at the several stations, we obtain the differences given in the sixth column above. At Cote sans Dessein, the difference between the observed and computed dip amounts to 63′.9. An error of one degree may perhaps have been committed in recording or transcribing this observation. At all events this observation seems entitled to less weight than the others, and we shall perhaps do best to reject it altogether. The remaining equations solved as before, furnish us $\delta=.97301$, $x=+0.01301$, $y=+0.00397$. Computing again the dip at the several stations, we obtain the differences given in the last column above. The mean dip at St. Louis for 1819 was then, according to these observations, 69° 59′.8. The dip in 1840, according to p. 102, was 69° 20′.7. Decrease 39′.1 in twenty one years, that is, 1′.9 per year. This result would be deserving of confidence if the observations of 1819 could be depended upon. For information on this point, I wrote to Major Graham, who made the observations in question, from whom I learned that the poles of the needle employed were never reversed; and that he knew of no data for determining the correction necessary for this omission. Here then is a constant error of unknown amount, which renders the observations quite useless for our present purpose. This is a result much to be regretted; yet if no observations were made at the time with the polarity of the needle reversed, the loss seems irreparable; for if the instrument were still preserved and in good condition, we obviously could not assume the inequality of the arms of the needle to be the same as in 1819. I do not find then any observations of dip made in this country before 1822, which are capable of informing us whether the dip has been increasing or diminishing.

The next observations in respect of age were made at New York city. Here we have five observations. In order to deduce from them the most probable results, let us put δ for the mean dip, Jan. 1, 1822, and Δ for the annual motion; we thus obtain five equations of condition.

Observations.			Equations of condition.	Differences.	Differences.
1822. Dec.,	73°	0′.5	$\delta+\ \ .953\varDelta=60'.5$	$-15'.96$	$+0'.58$
1825. March,	73	27 .0	$\delta+\ 3.200\varDelta=87\ .0$	$+15\ .02$	
1833. April 1,	72	49 .3	$\delta+11.246\varDelta=49\ .3$	$-\ \ 6\ .63$	
1834. Aug. 7,	72	51 .7	$\delta+12.597\varDelta=51\ .7$	$-\ \ 1\ .54$	$-1\ .92$
1839. Sept. 9,	72	52 .2	$\delta+17.687\varDelta=52\ .2$	$+\ \ 9\ .12$	$+1\ .34$

These equations furnish us $\delta=78'.365$, $\varDelta=-1.9947$, from which data we obtain the differences in the third column above. But three of these observations, viz. the first, fourth, and fifth, were made at the same locality, and are much better suited for comparison. These give $\delta=60'.434$, $\varDelta=-0.5411$, and the differences computed are given in the last column above. I regard this as the most probable value of $\varDelta$ afforded by the New York observations. In determining the absolute value of the dip, I know no reason for rejecting the other two observations, and assuming the last determined value of $\varDelta$, the most probable value of δ is 65′.084, which gives for Jan. 1, 1840, 72° 55′.34. It will be noticed I have gone upon the supposition that the motion of the needle has been uniform throughout the entire period; yet the last three observations might lead us to infer that since 1833 the dip had been sensibly stationary.

I know of no other observations made in the United States before the year 1833. In the years 1833 and '34, the dip was observed at several places by Prof. Bache and others; and in the year 1839 I observed at the same stations. The observations were made with different instruments, and seldom at exactly the same localities; nevertheless it may be instructive to institute a comparison. The following table exhibits the two series of observations, with the interval elapsed and the change of dip.

Station.	Date.	Dip.	Observer.	Station.	Date.	Dip.	Observer.	Int'rval in yrs.	Change of dip.
Albany,	April, 1833	74° 51′.1	Prof. Henry,	Alb'ny,	Sept. 4, 1839	74° 51′.3	Prof. Loomis,	5.728	+5′.7
"	Aug. 11, 1834	74 40.1	Prof. Bache,						
Springfield,	Aug. 10, 1834	74 10.7	" "	Spring.,	" 14, 1839	74 6.9	" "	5.096	−3 8
Providence,	Aug 8, 1834	74 2.8	" "	Prov.,	" 19, 1839	73 59.6	" "	5.115	−3.2
West Point,	April 15, 1833	73 25.8	Prof. Courtenay	W. Pt.,	" 5, 1839	73 27.4	" "	5.819	−4.1
"	June 7, 1834	73 37.2	" "						
Philadelphia,	July 29, 1834	72 0.2	Prof. Bache,	Philad.,	1838	71 43.9	Prof. Bache,	5.069	−5.4
				"	" 23, 1839	72 7.1	Prof. Loomis.		
				"	" 13, 1840	71 53.3	Prof. Bache.		

The entire change of dip, divided by the number of years, gives $-0'.4026$ for the annual motion, which result accords very well with the last value of $\varDelta$ before determined.

The observations made at Hudson are confined to a short period, nevertheless they possess certain important advantages for comparison. They were all made with the same instrument, at identically the same locality, by the same individual, and after the same method. The following table exhibits the materials for comparison. In the equations of condition, δ represents the mean dip for Jan. 1, 1838, and Δ the annual change of dip.

Observations.			Equations of condition.	Differences.
1838.	Sept. 8,	72° 48′.2	$\delta+\ .684\Delta=8'.2$	+0′.1
1839.	April 22,	46 .8	$\delta+1.304\Delta=6\ .8$	− 1 .4
	Aug. 17,	48 .4	$\delta+1.624\Delta=8\ .4$	+0 .2
1840.	Jan. 11,	49 .5	$\delta+2.027\Delta=9\ .5$	+1 .2
	Aug. 31,	49 .5	$\delta+2.665\Delta=9\ .5$	+1 .1
1841.	May 10,	47 .4	$\delta+3.353\Delta=7\ .4$	−1 .2
	Nov. 4,	48 .7	$\delta+3.841\Delta=8\ .7$	0 .0

These equations give us $\delta=7'.95$, or the mean dip Jan. 1, 1838, equals 72° 47′.95, $\Delta=+0'.18$, from which we obtain the differences between the observed and computed dips as given in the last column above. I consider then +0′.18 to be a near approximation to the annual change of dip at this place.

Through the politeness of Lieut. C. W. Younghusband, I have been furnished with a copy of the dip observations made at Toronto for 1841. The observations are seventy three in number, made generally twice a week, from April 10th to the end of the year. These have furnished me the following equations of condition, in which δ represents the mean dip for Jan. 1, 1841, and Δ the annual motion.

Equations.	Diff.	Equations.	Diff.	Equations.	Diff.
$\delta+.271\Delta=6'.8$	+1′.7	$\delta+.405\Delta=3'.0$	−2′.9	$\delta+.559\Delta=3'.4$	−3′.4
$\delta+.282\Delta=4.2$	−1.0	$\delta+.416\Delta=3.6$	−2.3	$\delta+.569\Delta=3.3$	−3.5
$\delta+.290\Delta=6.1$	+0.9	$\delta+.424\Delta=6.2$	+0.2	$\delta+.578\Delta=5.6$	−1.3
$\delta+.301\Delta=5.3$	0	$\delta+.435\Delta=5.2$	−0.9	$\delta+.589\Delta=4.0$	−2.9
$\delta+.309\Delta=8.4$	+3.1	$\delta+.444\Delta=6.2$	+0.1	$\delta+.597\Delta=5.4$	−1.6
$\delta+.320\Delta=6.2$	+0.8	$\delta+.454\Delta=8.3$	+2.1	$\delta+.608\Delta=2.5$	−4.5
$\delta+.329\Delta=7.1$	+1.7	$\delta+.463\Delta=8.4$	+2.2	$\delta+.616\Delta=4.7$	−2.4
$\delta+.339\Delta=5.6$	+0.1	$\delta+.474\Delta=6.5$	+0.2	$\delta+.627\Delta=3.3$	−3.8
$\delta+.348\Delta=4.9$	−0.7	$\delta+.482\Delta=5.0$	−1.3	$\delta+.635\Delta=3.0$	−4.2
$\delta+.359\Delta=5.3$	−0.3	$\delta+.493\Delta=11.9$	+5.5	$\delta+.646\Delta=6.3$	−1.0
$\delta+.367\Delta=7.3$	+1.6	$\delta+.520\Delta=9.2$	+2.7	$\delta+.654\Delta=2.4$	−4.9
$\delta+.378\Delta=13.3$	+7.6	$\delta+.531\Delta=4.8$	−1.8	$\delta+.665\Delta=10.6$	+3.2
$\delta+.386\Delta=9.7$	+3.9	$\delta+.539\Delta=3.6$	−3.0	$\delta+.674\Delta=9.2$	+1.8
$\delta+.397\Delta=2.5$	−3.3	$\delta+.550\Delta=1.6$	−4.9	$\delta+.684\Delta=1.5$	−6.0

TABLE CONTINUED.

Equations.	Diff.	Equations.	Diff.	Equations.	Diff.
$\delta+.693\Delta=7'.1$	$-0'.4$	$\delta+.799\Delta=7'.1$	$-1'.0$	$\delta+.895\Delta=8'.6$	$-0'.1$
$\delta+.704\Delta=7.9$	$+0.3$	$\delta+.808\Delta=10.0$	$+1.8$	$\delta+.903\Delta=8.0$	-0.7
$\delta+.712\Delta=11.1$	$+3.5$	$\delta+.819\Delta=10.7$	$+2.5$	$\delta+.914\Delta=13.1$	$+4.3$
$\delta+.723\Delta=7.4$	-0.3	$\delta+.827\Delta=10.3$	$+2.0$	$\delta+.923\Delta=9.4$	$+0.6$
$\delta+.731\Delta=14.1$	$+6.4$	$\delta+.838\Delta=10.5$	$+2.2$	$\delta+.934\Delta=7.2$	-1.7
$\delta+.742\Delta=10.3$	$+2.5$	$\delta+.846\Delta=10.8$	$+2.4$	$\delta+.942\Delta=7.1$	-1.8
$\delta+.750\Delta=8.5$	$+0.7$	$\delta+.857\Delta=6.6$	-1.9	$\delta+.953\Delta=8.2$	-0.8
$\delta+.761\Delta=11.0$	$+3.1$	$\delta+.865\Delta=7.9$	-0.6	$\delta+.961\Delta=10.5$	$+1.5$
$\delta+.769\Delta=9.3$	$+1.3$	$\delta+.876\Delta=3.6$	-5.0	$\delta+.972\Delta=15.5$	$+6.4$
$\delta+.780\Delta=5.9$	-2.1	$\delta+.884\Delta=7.4$	-1.2	$\delta+.991\Delta=8.4$	-0.8
$\delta+.789\Delta=7.5$	-0.6				

The preceding equations give $\delta=3'.57$, or the mean dip Jan. 1, 1841, equals $75^\circ\ 13'.57$, $\Delta=+5'.69$, from which we obtain the differences between the observed and computed dip as given in the table above. Although these observations are quite numerous, and were doubtless made with great care, still being all embraced within a period of less than nine months, they leave considerable uncertainty with regard to the annual motion.

In "Cist's Cincinnati in 1841," Prof. Locke has given the result of monthly observations of the dip at Cincinnati for one year. The mean of the observations for the first six months is $0'.13$ greater than for the last, indicating an annual diminution of dip of $0'.26$. This result, however, being derived from so short a period, cannot be allowed much weight. These are all the materials to which I have had access for determining the annual change of dip in the United States. I have sought for further light on this subject from a comparison of European observations. The following table shows the annual change of dip in Europe according to Quetelet. These numbers with the motion at New York may be tolerably well represented by the formula $-3'.3605$ sin. $(79^\circ\ 54'+\text{lon.})=\Delta$, where the longitude is reckoned from Greenwich $+$E, $-$W.

Station.	Longitude.	Annual motion.	Comp.	Diff's.	Station.	Longitude.	Annual motion.	Comp.	Diff's.
New York,	$-74^\circ\ 1'$	$-0'.5$	$-0'.34$	$-0'.16$	Göttingen,	$+9^\circ\ 56'$	$-3'.05$	$-3'.36$	$+0'.31$
Dublin,	$-6\ 15$	2.3	3.22	$+0.92$	Christiania,	10 44	3 56	3.36	-0.20
London,	0 0	2.4	3.30	$+0.90$	Florence,	11 16	3.3	3.36	$+0.06$
Paris,	$+2\ 21$	3.7	3.33	-0.37	Berlin,	13 24	3.7	3.35	-0.35
Brussels,	$+4\ 22$	3.4	3.34	-0.06	Upsal,	17 26	3.27	3.33	$+0.06$
Turin,	$+7\ 40$	3.5	3.35	-0.15	Stockholm,	18 4	3.13	3.33	$+0.20$
Milan,	$+9\ 9$	3.87	3.36	-0.51	Petersburgh,	30 19	3.8	3.15	-0.65

The same formula gives for Hudson $\Delta=+0'.09$. The results of the observations in the United States are by no means satis-

factory, yet I think we shall not be very far from the truth if we assume that the dip in the eastern states decreases 0′.5 per year, and is stationary in the western states. In the subsequent discussion, I have in part evaded the difficulty, by assuming Jan. 1, 1840, as the common epoch, which is not far from the mean time of the observations.

In discussing the observations, I have divided them into four groups according to longitude. The following table contains all the observations between longitudes 71° and 78° W. which I have been able to obtain. Where several observations have been made at the same locality, I have endeavored to deduce the most probable mean result.

TABLE I.—*Observations of the Magnetic Dip from 71° to 78° west longitude.*

Station.	Lat.	Lon.	Dip.	Date.	Authority.	Dip Jan. 1, 1840.	Diff.
	° ′	° ′	° ′			° ′	′
Montreal,	45 30	73 42	76 42.7	1835. Nov. 25	Capt. Back and Major Estcourt,	76 40.7	−14.8
Oswego,	43 26	76 36	75 11.3	1839. Sept. 1	Prof. Loomis,	75 11.1	+ 4.8
Utica,	43 7	75 13	74 57.2	1839. Sept. 3	" "	74 57.0	+ 3.8
Syracuse,	43 0	76 14	74 50.9	1839. Sept. 2	" "	74 50.7	+ 5.4
Schenectada,	42 48	73 55	74 36.1	1839. Sept. 3	" "	74 35.9	− 4.1
Albany,	42 39	73 45	74 47.5	1835. Nov. 10	Profs. Henry, Bache, and Loomis,	74 45 4	+12.5
Cambridge,	42 22	71 8	74 20.1	1839. Sept. 17	Prof. Loomis,	74 19.9	− 4.0
Dorchester,	42 19	71 4	74 19.0	1839.	Prof. Bond,	74 18.8	− 2.9
Worcester,	42 16	71 48	74 20.6	1839. Sept. 16	Prof. Loomis,	74 20 4	+ 2.7
Springfield,	42 6	72 36	74 8.8	1837. Feb. 26	Profs. Bache and Loomis,	74 7.4	− 0.3
Longmeadow,	42 2	72 36	74 5.3	1839. Sept. 14	Prof. Loomis,	74 5.1	+ 0.7
Providence,	41 49	71 25	74 1.2	1837. Feb. 27	Profs. Bache and Loomis,	73 59.8	+ 3.8
Hartford,	41 46	72 41	73 58.1	1839. Sept. 13	Prof. Loomis,	73 57.9	+ 7.0
West Point,	41 23	74 0	73 30.1	1835. Oct. 19	Profs. Courtenay and Loomis,	73 28.0	− 1.0
New Haven,	41 18	72 58	73 26.7	1839. Sept. 11	Prof. Loomis,	73 26.5	− 0.5
New York,	40 43	74 1	72 55.3	1840. Jan. 1	Messrs. Sabine, Franklin, Back, Bache, and Loomis,	72 55.3	− 0.4
Princeton,	40 22	74 40	72 47.1	1839. Sept. 21	Prof. Loomis,	72 46.9	+10.1
Philadelphia,	39 57	75 11	71 56.1	1838. May 20	Profs. Bache and Loomis,	71 55.3	−19.3
Baltimore,	39 17	76 37	71 35.6	1840. May 16	Messrs. Courtenay, Loomis, Bache, Nicollet, and Graham,	71 35.8	− 2.6
Washington,	38 53	77 1	71 17.5	1839. Feb. 9	Lieut. Wilkes and Prof. Loomis,	71 17.0	− 0.5

The observations are all reduced to Jan. 1, 1840, by applying the annual motion −0′.5. Adopting for the central position latitude 41° 51′ N., longitude 73° 52′ W., we obtain twenty equations of condition of the usual form. From these equations we obtain $\delta=2.8772$, $x=+.01389$, $y=+.00077$, and the direction of the isoclinal line is from N. 86° 50′ W. to S. 86° 50′ E. The increase of dip in the normal direction is 50′.077 to sixty geographical miles. Computing from these data the dip at the several stations, we obtain the differences given in the last column above. Four of these differences exceed ten minutes. The assumed dip at Montreal is the mean of the two following observations:

77° 6′.4	1833. April 19.	Capt. Back.
76 19	1838.	Major Estcourt.

As the computed dip falls between the two observations, it cannot be pronounced inadmissible.

At Albany, observations made within about a year of each other differ 11′. Here then is evidence of local attraction. The least observed dip reduced to 1840 differs 4′.5 from the computed dip. At Princeton, the dip is derived from a single observation. At Philadelphia, observations made within a year of each other differ 23′.2. Here is undoubted local attraction. My own observation differs 7′.5 from the computed dip.

In order to test the hypotheses upon which the dip is computed, let us classify the differences. The mean difference at the ten most northerly stations is +0′.3; at the ten most southerly −0′.3; at the five most eastern 0′.0; at the five most western +2′.2; at the ten intermediate stations −1′.1. It may be inferred then that within the limits of the preceding table, the hypothesis of straight, parallel, and equidistant isoclinal lines, is well nigh rigorously exact. There is then reason to believe that these differences between the observed and computed dip, arise chiefly from local attraction and errors of observation. As the dip observed at Charlottesville, Va. in 1834, 71° 8′.7, is about half a degree greater than observations made in other parts of the United States would lead us to expect, I have thought best to omit it in this comparison.

TABLE II.—*Observations of the Magnetic Dip from 78° to 83° west longitude.*

Station.	Lat.	Lon	Dip.	Date.	Authority.	Diff.
Toronto,	43°33′	79°20′	75°13′.6	1841. Jan. 1,	Lt. Younghusband.	− 3′.0
Buffalo,	42 53	78 55	74 40 .8	1839. Aug. 31,	Prof. Loomis.	− 4 .5
Detroit,	42 19	82 56	73 36 .7	1841. April 1,	"	+ 1 .8
Cleveland,	41 30	81 42	73 14 .6	1840. Oct. 1,	"	+10 .9
Sandusky,	41 29	82 40	72 57 .8	1839. May 20,	"	+ 4 .8
Kinsman,	41 28	80 34	73 8 .1	1840. Sept. 10,	"	− 5 .4
Bedford,	41 24	81 32	72 58 .1	1840. Sept. 23,	"	− 1 .9
Hartford,	41 20	80 34	72 59 .8	1840. Sept. 10,	"	− 6 .6
Bazetta,	41 20	80 45	72 59 .7	1840. Sept. 9,	"	− 4 .8
Aurora,	41 20	81 20	72 55 .5	1840. Sept. 8,	"	− 3 .0
Twinsburgh,	41 20	81 26	72 51 .3	1840. Sept. 23,	"	− 6 .2
Warren,	41 16	80 49	73 0 .7	1840. Sept. 11,	"	+ 0 .4
Windham,	41 15	81 3	73 3 .4	1840. Sept. 8,	"	+ 6 .4
Shalersville,	41 15	81 13	72 56 .6	1840. Oct. 15,	"	+ 1 .3
Streetsboro',	41 15	81 20	72 53 .0	1840. Oct. 16,	"	− 1 .1
Hudson,	41 15	81 26	72 48 .3	1840. Jan. 1,	"	− 4 .8
Tallmadge,	41 6	81 26	72 51 .2	1841. March 3,	"	+ 6 .1
Clinton,	40 58	81 40	72 44 .0	1841. Oct. 12,	"	+ 8 .5
Fulton,	40 55	81 38	72 38 .9	1841. Oct. 12,	"	+ 5 .7
Beaver,	40 44	80 24	72 40 .3	1839. Oct. 1,	"	+ 4 .2
Dover,	40 33	81 30	72 19 .2	1841. Oct. 11,	"	+ 4 .2
Pittsburgh,	40 32	80 2	72 38 .9	1839. Sept. 30,	"	+ 9 .6
Frasersburgh,	40 9	82 8	71 48 .7	1841. Oct. 9,	"	+ 1 .7
Hebron,	39 59	82 29	71 10 .1	1841. Oct. 8,	"	−24 .3

Adopting for the central position, lat. 41° 18′ N., lon. 81° 12′ W., we obtain the usual equations, which furnish us $\delta=1.96851$, $x=+.01483$, $y=+.00378$, and the direction of the isoclinal line is from N. 75° 42′ W. to S. 75° 42′ E. The increase of dip in the normal direction is 55′.081 to sixty geographical miles. Computing from these data the dip at the several stations, we obtain the differences given in the last column above. Two of these differences exceed ten minutes, viz. at Cleveland and Hebron. I have observed the dip near Cleveland four times, on different sides of the city, with the following results:

May 9, 1839,	on the north	side of	the city,	73° 26′.0
Sept. 22, 1840,	" south		"	12 .0
April 23, 1841,	" west		"	16 .3
Aug. 12, 1841,	" east		"	4 .3

The assumed dip is the mean of these four observations, and as the computed dip is almost identical with one of the observations, it cannot be pronounced inadmissible. At Hebron, observations were made at two stations, distant about ten rods from each other, with sensibly the same result. As however at Frasersburgh, distant but about twenty miles, the computed dip agrees well with the observed, we may presume that this disturbance is quite limited in extent.

Classifying the differences in the same manner as with table I, the mean at the twelve northern stations is $-1'.5$; at the twelve southern $+1'.5$; at the six most eastern $-0'.9$; at the six most western $-0'.3$; at the twelve intermediate $+0'.6$.

TABLE III.—*Observations of the Magnetic Dip from* 83° *to* 86° *west longitude.*

Station.	Lat.	Lon.	Dip.	Date.	Authority.	Diff.
Gros Cap,	46°32′	84°43′	77° 5′.3	1841. Aug. 26	Prof. Loomis,	−10′.7
Fort Brady,	46 30	84 24	77 29 .7	1841. Aug. 26	" "	+16 .1
Mackinac,	45 51	84 41	76 37 .5	1841. Aug. 21	" "	− 2 .2
South Maniton,	45 5	85 38	75 59 .3	1841. Aug. 31	" "	− 1 .6
Ann Arbor,	42 18	83 37	73 15 .2	1840. June 30	" "	−14 .2
Ypsilanti,	42 14	83 32	73 18 .4	1840. June 30	" "	− 7 .4
Monroe,	41 55	83 20	73 25 .6	1840. June 30	" "	+17 .0
Toledo,	41 41	83 25	73 6 .1	1839. May 17	" "	+ 9 .8
Maumee,	41 34	83 32	72 49 .1	1839. May 18	" "	− 1 .3
Pigna,	40 6	84 10	71 35 .8	1840. Aug. 22	Prof. Locke,	+ 1 .9
Urbanna,	40 3	83 39	71 29 .9	1833. March 30	" "	− 0 .3
Columbus,	39 57	83 3	71 4 .3	1840. Jan. 4	Profs. Locke and Loomis,	−19 .3
Springfield,	39 53	83 42	71 27 .4	1833. March 29	Prof. Locke,	+ 6 .0
Dayton,	39 45	84 5	71 22 .4	1839. June 7	" "	+ 7 .3
Lebanon,	39 26	84 6	71 3 .3	1840. Aug. 24	" "	+ 4 .9
Hamilton,	39 23	84 32	70 59 .6	1840. Aug. 20	" "	+ 3 .0
Mason,	39 22	84 13	70 54 .2	1840. Aug. 25	" "	− 0 .9
Cincinnati,	39 6	84 27	70 27 .8	1841. March 12	Profs. Locke and Loomis,	−13 .6
Williamstown,	38 36	84 30	70 4 .1	1840. Sept. 1	Prof. Locke,	−10 .9
Louisville,	38 18	85 37	70 1 .6	1840. April 22	" "	+ 0 .2
Frankfort,	38 14	84 40	69 54 .7	1840. Sept. 4	" "	− 1 .2
Lexington,	38 6	84 18	69 54 .5	1840. Sept. 2	" "	+ 6 .4
Clay's Ferry,	37 53	84 18	69 48 .0	1840. Sept. 3	" "	+11 .4

Adopting for the central position, latitude 40° 57′ N., longitude 84° 11′ W., we obtain $\delta = 3.31612$, $x = +.014728$, $y = -.000735$, the direction of the isoclinal line is from S. 87° 8′ W. to N. 87° 8′ E., and the increase of dip in the normal direction is 53′.088 for sixty geographical miles. The mean of the differences at the eleven most northern stations is +0′.6, at the twelve most southern −0′.6, at the five most eastern stations −0′.2, at the six most western −2′.1, at the twelve intermediate +1′.1. Eight of these differences exceed ten minutes.

TABLE IV.—*Observations of the Magnetic Dip from 86° to 91° west longitude.*

Station.	Lat.	Lon.	Dip.	Date.	Authority.	Diff.
Prairie du Chien,	43° 3′	90°53′	73°16′.6	1839. Oct. 25	Prof. Locke,	−14′.1
Madison,	43 3	89 11	74 5 .0	1840. Oct. 5	Profs. Locke and Loomis,	+23 .9
Campbell's,	43 1	89 26	73 28 .1	1841. Sept. 9	Prof. Loomis,	− 9 .6
Blue Mounds,	43 0	89 36	73 37 .9	1840. Oct. 3	Profs. Locke and Loomis,	+ 2 .3
Hickok's,	42 58	89 47	73 39 .5	1841. Sept. 9	Prof. Loomis,	+ 6 .8
Mineral Point,	42 51	89 58	73 21 .8	1840. Oct. 6	Profs. Locke and Loomis,	− 3 .0
Platteville,	42 43	90 14	73 17 .4	1841. Sept. 11	Prof. Loomis,	+ 1 .9
Turkey River,	42 42	90 48	73 11 .0	1839. Oct. 23	Prof. Locke,	− 0 .1
Little Mahoqueta,	42 31	90 31	73 8 .0	1839. Oct. 20	" "	+ 5 .7
Dubuque,	42 29	90 23	73 5 .0	1839. Oct. 14	" "	+ 3 .8
Galena,	42 28	90 13	73 3 .0	1841. Sept. 7	Prof. Loomis,	+ 1 .8
Sherwood's,	42 27	90 37	73 7 .0	1839. Oct. 11	Prof. Locke,	+ 9 .2
North bank Mah.,	42 23	90 52	72 51 .0	1839. Oct. 9	" "	− 1 .4
Whitewater,	42 18	90 38	72 55 .1	1839. Oct. 8	" "	+ 6 .0
Mahoqueta,	42 14	90 57	72 43 .6	1839. Oct. 1	" "	+ 0 .3
Farmer's Creek,	42 13	90 23	72 33 .1	1839. Oct. 5	" "	−12 .7
Small Mill,	42 4	91 2	72 21 .4	1839. Sept. 30	" "	−11 .8
Iron Ore,	41 55	90 40	72 50 .0	1839. Sept. 27	" "	+23 .2
Chicago,	41 53	87 44	72 47 .7	1841. Sept. 2	Prof. Loomis,	+ 4 .6
Wapsipinnicon,	41 45	90 23	72 14 .9	1839. Sept. 25	Prof. Locke,	− 4 .0
Lost Grove,	41 39	90 9	72 2 .4	1839. Sept. 23	" "	−12 .3
Davenport,	41 28	90 18	71 55 .0	1839. Sept. 13	" "	− 8 .0
Peru,	41 23	89 5	71 51 .1	1841. Sept. 16	Prof. Loomis,	−14 .9
Pekin,	40 35	89 36	71 13 .2	1841. Sept. 18	" "	− 3 .6
Copperas Creek,	40 30	89 48	71 4 .0	1841. Sept. 18	" "	− 6 .7
Montrose,	40 19	90 14	70 54 .0	1839. Sept. 11	Prof. Locke,	− 3 .4
Marion,	39 44	90 14	70 20 .1	1839. Sept. 9	" "	− 3 .7
Louisiana,	39 23	90 50	69 51 .1	1839. Sept. 8	" "	− 8 .7
Bunker Hill,	39 4	89 53	69 49 .1	1841. Sept. 24	Prof. Loomis,	+ 1 .4
Monticello,	38 57	90 5	69 38 .9	1841. Sept. 25	" "	− 0 .8
Upper Alton,	38 55	90 3	69 45 .7	1841. Sept. 23	" "	+ 7 .6
Alton,	38 54	90 4	69 34 .8	1841. Sept. 22	" "	− 2 .2
Edwardsville,	38 50	89 53	69 57 .7	1841. Sept. 23	" "	+23 .4
Vincennes,	38 43	87 29	69 52 .3	1841. Mar. 26	Profs. Locke and Loomis,	+ 9 .0
St. Louis,	38 37	90 4	69 28 .3	1840. Sept. 17	" " "	+ 7 .6
Paoli,	38 35	86 25	69 35 .5	1840. Sept. 20	Prof. Locke,	− 7 .1
Princeton,	38 23	87 30	69 22 .6	1840. Sept. 16	" "	− 1 .5
New Harmony,	38 11	87 48	69 5 .0	1840. Sept. 11	" "	− 5 .6
Mount Vernon,	37 59	87 47	68 56 .3	1840. Sept. 10	" "	− 3 .0

Adopting for the central position, latitude 41° 2′ N., longitude 89° 47′ W., we obtain $\delta = 3.69143$, $x = +0.015972$, $y = +0.002319$, the direction of the isoclinal line is from N. 81° 44′ W. to S. 81° 44′ E., and the increase of dip in the normal direction is 58′.106 for sixty geographical miles. The mean of the differences at the twenty most northerly stations is +1′.6, at the nineteen most

southerly $-1'.6$, at the ten most easterly $-0'.2$, at the ten most westerly $+0'.8$, at the nineteen intermediate $-0'.3$.

The preceding comparisons furnish us with the following results, where column third shows the dip, column fourth the direction of the isoclinal line, and column fifth the increase of dip in the normal direction for sixty geographical miles at the points whose latitudes and longitudes are shown in the first and second columns.

Latitude.	Longitude.	Dip.	Direction of isoclinal line.	Increase of dip.
41° 51′	73° 52′	73° 52′.63	N. 86° 50′ W.	50′.077
41 18	81 12	72 58.11	N. 75 42 W.	55.081
40 57	84 11	72 18.97	S. 87 8 W.	53.088
41 2	89 47	71 41.49	N. 81 44 W.	58.106

With these data, we may trace with some confidence the isoclinal lines of 72° and 73°. They will pass through the following points.

Line of 73° dip.		Line of 72° dip.		
Latitude.	Longitude.	Latitude.	Longitude.	Direction.
40° 47′.85	73° 52′	39° 35′.85	73° 52′	N. 86° 50′ W.
41 20.12	81 12	40 12.67	81 12	N. 75 42 W.
41 43.43	84 11	40 35.54	84 11	S. 87 8 W.
42 23.92	89 47	41 21.32	89 47	N. 81 44 W.

The isoclinal lines are curved lines passing through the above named points and in the directions here given. In the eastern part of the United States this curvature is very gradual and uniform, but near the longitude of 83° 30′ there is a point of inflexion. The isoclinal lines become concave towards the south. This interruption of the general regularity soon ceases, and in the neighborhood of the Mississippi the isoclinal lines are tolerably well represented by portions of the same circular arcs as near the Atlantic. The position here described differs but slightly from that represented on my chart, Vol. 39, p. 41. Other isoclinal lines may be drawn on each side of these from the same data, but with somewhat greater uncertainty. How now are we to regard the differences contained in the last column of the preceding tables? Do they indicate errors of observation,* errors of the hy-

* I much regret that Prof. Locke should have interpreted a former paper of mine (Vol. XL, p. 85) as a 'special effort to discredit his observations.' Such was far from my intention. I had always regarded Prof. Locke's observations as exceedingly valuable, especially as they were made in a region hitherto wholly unex-

potheses on which they are computed, or errors of a different kind? They cannot be principally errors of observation. At several of the stations where the differences are greatest, such as Philadelphia, Columbus, Cincinnati, and Madison, the dip has been repeatedly observed by different individuals, and nearly uniform results obtained. Do they indicate errors of the hypotheses on which they are computed? These hypotheses are that the isoclinal lines over a limited territory are straight, parallel, and equidistant. Doubtless each of these hypotheses may be erroneous, and if the lines are extended over any very considerable portion of the globe, will be palpably so. But how great are these errors within the limits of my several tables? The observations themselves afford data for estimating the errors. The error arising from curvature and want of parallelism of the isoclinal lines, will appear in the unequal mean differences under the several meridians; and that arising from the lines not being equidistant, will appear in the unequal mean differences under the several parallels. We have already seen that for each of the tables, these errors are much less than the mean of the differences.

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plored. But Prof. Locke claimed for his observations an extraordinary degree of accuracy; an accuracy much greater than I could claim for my own, and greater than I had seen claimed by any former observer. In his own language he expected his results would be received with '*surprise;*' and I thought it not amiss to enquire whether the individual observations gave indications of this extraordinary precision. The result was the development of anomalies of precisely the same kind as had perplexed me in my own observations. These anomalies doubtless in a measure neutralize each other by being alternately positive and negative, and are still further reduced by division, so that the mean results may be valuable in spite of them. I have lately had an opportunity of comparing my own observations with Prof. Locke's, by going upon several of his localities. The following is the result of the observations.

	Prof. Locke.		Prof. Loomis.		
	Dip.	Date.	Dip.	Date.	Diff.
Madison,	74° 3′.5	1839. Nov. 2.	74° 6′.5	1841. Sept. 8.	+3′.0
Blue Mounds,	73 40 .9	1839. Oct. 30.	73 34 .9	1841. Sept. 7.	−6 .0
Mineral Point,	73 20 .6	1839. Nov. 5.	73 23 .0	1841. Sept. 6 & 10.	+2 .4
Vincennes,	69 51 .9	1840. Sept. 18.	69 52 .8	1841. Oct. 1.	+0 .9
St. Louis,	69 31 .1	1839. Sept. 5.	69 25 .5	1841. Sept. 29.	−5 .6
Cincinnati,	70 27 .9	1840. Aug. 26.	70 27 .7	1841. Oct. 5.	−0 .2
Columbus,	71 4 .9	1838. April 3.	71 3 .7	1841. Oct. 8.	−1 .2

At none of the above places were the stations employed identically the same except at Cincinnati, and here I have taken for Prof. Locke's result the mean of a year's monthly observations. My own results are upon an average not quite one minute less than Prof. Locke's. I am satisfied then that the two series of observations may be compared, as if they were all made with one instrument.

The differences obtained, after assigning to each isoclinal line its most probable position, will not be identically the same as given in the last column of the preceding tables. In Table I, where the curvature of the isoclinal lines is most gentle and uniform, the discrepancy is slight; in Table II the discrepancy is not great; in Table III, where the isoclinal lines are somewhat undulating, the discrepancies are greater, particularly near the limits of the table; and in Table IV, the discrepancies are quite appreciable at the extreme stations. But making the necessary allowance for these discrepancies, we have still left unaccounted for large differences, amounting at several stations to over fifteen minutes. How are these to be explained? The observations themselves will suffice to answer this question. In 1834, the dip was observed at Baltimore by Prof. Courtenay 70° 58′.6. The dip, according to my computation, should be 71° 38′.4. Difference −39′.8. In 1839 the dip was observed by myself 71° 50′.3. Difference +11′.9. The dip has since been observed by Prof. Bache, Major Graham, and Mr. Nicollet, who have obtained results ranging between 71° 31′.9 and 71° 47′.2. The mean of all the observations is 71° 35′.6, differing from my computation −2′.8. Extreme range of the observations 51′.7. If we reject the observation of Prof. Courtenay, which differs most from the mean, the accordance will be still better. It is obvious, then, that there prevails about Baltimore some influence which causes the dip to change in moderate distances very abruptly. At Philadelphia, observations made within a year of each other in different parts of the city, vary 23′.2. At New York, observations at eight years' interval differ 37′.7. At Montreal, two observations differ 47′.4. At Cleveland, observations by myself at stations about a mile distant differed 21′.7. At Monroe, observations by myself on opposite sides of the town differed 13′.3. In general we may conclude, that wherever the dip is found to be greatly different from what was to be expected from its latitude and longitude, observations made at stations but moderately distant from each other, often less than a mile, will differ materially. Those influences, then, which occasion *abrupt* deviations from the general law of increase of dip with the latitude are quite limited in extent, unlike the principal part of the force which gives direction to the needle. This fact is specially insisted upon by the magnetic committee of the British Association, of which Sir John

Herschel is chairman. The committee urge the importance of magnetic surveys of the surrounding districts in connection with the observations at central stations. "By this means alone can the amount of *station error* for each element at the central stations be ascertained; by which is meant, all that part of each resolved element of the magnetic force, which, not being participated in by the surrounding district, must be attributed to attractions merely local and accidental. Without such surveys, this error cannot be even approximately fixed." (See this Journal, Vol. XLII, p. 154.)

With regard then to the differences shewn in the last column of my four tables, they are all affected by the errors of observation, which however, are believed to be generally quite small, probably seldom exceeding one or two minutes; they are also affected by the errors of the hypotheses by which they are computed, yet it is believed that at few stations do these errors exceed two minutes. The principal part of these differences consists in the *station errors.*

II. *Variation of the Magnetic Needle.*

Although the magnetic chart contained in Vol. XXXIX, p. 41 of this Journal, is thought to give the variation of the needle with sufficient accuracy for common uses, yet for purposes of science it is desirable to attain the greatest possible precision. I have therefore instituted a careful examination of all the observations contained in my two former articles, with such additional observations as have since come to my knowledge. Of the latter class, the most important are those which are given by Prof. Locke in his Report on the Mineral Lands of the United States, Executive Documents, 1839–40, Vol. VI, No. 239, p. 134.

The first enquiry respects the present annual motion of the needle. The following table exhibits the principal materials for this investigation, all taken, with but two or three exceptions, from my former articles. Column fourth shews the *first* and *last* observations at each station employed in determining the annual motion which is shewn in column eighth, and column sixth shews the number of observations. When but two observations are employed, the annual motion is found by dividing the difference of the observations by the included interval, and this happens at

more than half the stations. When however several observations have been made, the result clearly should not rest solely upon the extreme observations. In such cases I have employed the method exemplified on the fourth page of this article, (p. 96.) In selecting the observations, I have preferred where practicable, to compare those which were made by the same individual. Such observations may be presumed to be affected by a constant error, which will have little influence upon the annual motion. Thus at Burlington, Vt. we have (Vol. 34, page 302) a series of observations by Mr. Johnson, from 1818 to 1834, quite consistent with each other; but in 1837 another observation by Prof. Benedict, decidedly inconsistent with the former. Without stopping to enquire which observations represent most accurately the mean variation at that place, it is obvious that the former are much the best suited to indicate the annual motion. Like considerations have guided my selection at other places.

	Lat.	Lon.	Variation.	Date.	No. obs.	Years embraced	Annual motion.	Interval of lines.	Products.	Motion comput'd
Burlington, Vt.	44°27′	73°10′	+7°30′	1818						
			8 50	1834	6	16	+4′.4	30.8	135.52	+5′.3
Chesterfield, N.H.	42 53	72 20	6 0	1820						
			7 45	1836	17	16	6.4	32.3	206.72	5.1
Deerfield, Mass.	42 34	72 29	5 28	1811						
			7 57	1837	2	26	5.7	33.0	188.10	4.9
Cambridge, Mass.	42 22	71 7	7 30	1810						
			9 18	1840	4	30	3.4	32.3	109.82	5.0
New Haven, Ct.	41 18	72 58	4 35	1819						
			6 10	1840	6	21	4.6	36.7	168.82	4.4
Keeseville, N. Y.	44 28	73 32	7 30	1825						
			8 40	1838	2	13	5.4	30.8	166.32	5.3
Albany, N. Y.	42 39	73 45	5 45	1818						
			6 47	1836	7	18	3.6	35.2	126.72	4.6
New York City,	40 43	74 1	4 40	1824						
			5 40	1837	3	13	3.7	45.5	168.35	3.6
Philadelphia,	39 57	75 11	2 25	1813						
			+3 52	1837	2	24	3.6	51.4	185.04	3.2
Milledgeville, Ga.	33 7	83 20	−5 30	1805						
			4 40	1835	2	30	1.7	69.9	118.83	2.3
Mobile, Ala.	30 40	88 11	8 10	1809						
			7 12	1835	2	26	2.2	110.1	242.22	1.5
Cleveland, O.	41 30	81 46	1 30	1825						
			35	1838	4	13	4.5	36.7	165.15	4.4
St. Clairsville, O.	40 10	80 52	3 10	1820						
			2 31	1838	2	18	2.2	37.1	81.62	4.4
New Madison, O.	39 56	84 37	5 23	1826						
			4 51	1838	2	12	2.7	51.4	138.78	3.2
Spring Bank, O.	39 45	83 47	4 54	1818						
			3 14	1838	2	20	5.0	46.1	230.50	3.5
Springboro, O.	39 31	84 16	5 30	1820						
			4 4	1838	2	18	4.8	51.9	249.12	3.1
Marietta, O.	39 25	81 26	2 36	1810						
			1 29	1838	2	28	2.4	33.2	91.68	4.3
Cincinnati, O.	39 6	84 27	5 15	1825						
			4 46	1840	2	15	2.0	52.9	105.80	3.1
Detroit, Mich.	42 24	82 58	3 13	1822						
			2 0	1840	4	18	4.3	41.1	176.73	4.0
Alton, Ill.	38 52	90 12	8 0	1835						
			7 45	1840	2	5	3.0	69.0	207.00	2.4

The annual motions shewn in this table indicate discrepancies which must be ascribed to local attraction and errors of observation. This is particularly true of the Ohio observations, some of the results being more than double of those at other stations moderately distant. The above results should be combined in such a manner as best to eliminate these errors. Within moderate limits, the motion at each locality may be presumed to be inversely as the distance between the lines of equal variation. This hypothesis is known to be untrue for the earth at large, yet it is worth inquiry whether the error is sensible within the limits of the United States. I have therefore multiplied each annual motion by the distance between the nearest lines of equal variation expressed in geographical miles. Column ninth of the preceding table shows the multipliers, and column tenth the products. These products, according to our hypothesis, should be constant. They are indeed quite variable, yet the extreme fluctuations occur in Ohio, at places where the mean motion of the needle must be supposed nearly the same. There is no decided inequality in the mean of these products for the different parts of the United States. I ascribe these inequalities then mainly to accidental causes and not to the hypothesis assumed. They probably arise in part from the employment of different years in determining the annual motion. The mean of all the products is 163.14, which divided by the distance between the lines of equal variation should give the annual motion. Column eleventh of the table shows the result of this computation. These numbers are alternately above and below those in column eighth; and in my opinion represent tolerably well the annual motion in this country. We may now proceed to discuss the absolute variation. In order to obviate as far as possible any objection arising from the uncertainty of the annual motion, I have confined myself to recent observations. Of the one hundred and ninety three observations employed, none were made before 1825, but ten before 1832, and one hundred and twenty were made since 1838. The observations are all reduced to January 1, 1840, by applying the annual motion computed in the manner just explained.

TABLE I.—10 *Stations.*

Station.	Latitude.	Longitude.	Variation.	Date.	Annual motion.	Variation 1840.	Differences.
	° ′	° ′	° ′		′	° ′	′
Angle of Maine,	48 0 N.	67 37	+19 12	1838	+8.8	+19 30	− 3
Penobscot Forks,	45 30	68 26	14 45	1825	8.1	15 25	+21
Barton,	44 45	72 9	10 51	1837	5.7	11 8	+31
Farmington,	44 42	70 3	11 20	1838	5.2	11 30	−55
Hampden,	44 37	68 46	13 4	1837	6.0	13 22	− 4
Dixfield,	44 30	70 14	12 0	1838	5.2	12 10	+13
Rumford,	44 30	70 27	11 0	1838	5.2	11 10	−35
Waterville,	44 27	69 32	12 8	1835	5.7	12 36	+ 6
Belfast,	44 18	68 54	13 0	1838	5.7	13 11	+21
West Thomaston,	43 56	69 5	12 0	1838	5.7	12 11	+ 4

Adopting for the central position latitude 44° 55′ N., longitude 69° 31′ W., we obtain ten equations of condition which furnish us $\delta = 2^\circ.2317$, i. e. $+13^\circ\ 13'.9$, $x = +.02555$, $y = +.02093$. Computing from these data the variation at the several stations, we obtain the differences given in the last column above. Mean difference at the six northern stations $+0'.5$; at the four southern $-1'.0$; at the three stations having the greatest computed variation $+4'.6$; three least $+3'.0$; four intermediate $-6'.0$.

TABLE II.—24 *Stations.*

Station.	Latitude.	Longitude.	Variation.	Date.	Annual motion.	Variation 1840.	Differences.
	° ′	° ′	° ′		′	° ′	′
Montreal,	45 31	73 35	+9 50	1835	+5.7	+10 18	+21
Champlain,	45 0	73 26	9 30	1838	5.7	9 41	+ 7
West Chazy,	44 52	73 25	9 21	1838	5.7	9 32	+ 4
Potsdam,	44 40	75 1	7 25	1835	5.4	7 52	− 5
Keeseville,	44 28	73 32	8 40	1838	5.3	8 51	− 8
Burlington,	44 27	73 10	9 27	1840	5.3	9 27	+11
St. Johnsbury,	44 26	72 6	9 16	1837	5.5	9 32	−36
Dial Mountain,	44 21	73 49	8 20	1838	5.5	8 31	− 7
Near Cedar Point,	44 3	73 33	8 23	1838	5.5	8 34	+ 1
Near West Moriah,	44 1	73 45	7 39	1838	5.5	7 50	−32
Crown Point,	43 55	73 27	8 47	1838	5.5	8 58	+27
Hanover,	43 42	72 14	9 15	1839	5.2	9 20	0
Warrensburgh,	43 26	73 45	7 15	1838	5.5	7 26	−22
Chesterfield,	42 52	72 29	8 14	1840	5.1	8 14	− 6
Troy,	42 44	73 40	6 4	1827	4.7	7 5	− 7
Williamstown,	42 43	73 13	7 45	1837	5.2	8 1	+27
Albany,	42 39	73 45	6 58	1840	4.6	6 58	− 5
Deerfield,	42 32	72 34	7 57	1837	4.9	8 12	+15
Cambridge,	42 22	71 8	9 12	1840	5.0	9 12	+10
Southwick,	42 4	72 46	8 15	1838	5.0	8 25	+64
House Point,	42 3	70 4	9 20	1835	5.0	9 45	+ 5
Hartford,	41 46	72 41	6 3	1829	5.0	6 58	−10
Hebron,	41 39	72 26	6 10	1835	5.0	6 35	−39
Newport,	41 28	71 21	7 0	1831	5.0	7 45	−15

Central position, latitude 43° 24′ N., longitude 72° 57′ W., $\delta = 2^\circ.44896$, i. e. $+8^\circ\ 26'.9$, $x = +.01585$, $y = +.01943$. Mean of the differences at the twelve northern stations $-1'.4$; twelve southern $+1'.4$; six stations having greatest computed variation $+0'.2$; five least $+0'.6$; thirteen intermediate $-0'.3$.

TABLE III.—17 *Stations.*

Station.	Latitude.	Longitude.	Variation.	Date.	Annual motion.	Variation 1840.	Differences.
	° ′	° ′	° ′		′	° ′	′
Ogdensburgh,	44 41	75 31	+6 10	1838	+5.4	+6 21	+ 4
Rossie,	44 22	75 43	6 43	1839	5.4	6 48	+51
Cazenovia,	42 54	75 54	4 0	1837	4.4	4 13	−45
Auburn,	42 54	76 38	3 43	1833	4.2	4 12	−10
Geneva,	42 52	77 3	3 49	1833	4.1	4 18	+17
Hamilton,	42 48	75 34	4 30	1837	4.4	4 43	−28
Homer,	42 38	76 15	5 5	1840	4.1	5 5	+33
Ithaca,	42 26	76 36	2 51	1833	4.1	3 20	−48
Oxford,	42 24	75 40	4 30	1837	4.4	4 43	− 9
Guilford,	42 22	75 30	4 30	1838	4.1	4 38	−21
West Point,	41 25	74 0	6 32	1835	4.0	6 52	+69
New Haven,	41 18	72 58	6 13	1840	4.4	6 13	−18
East Hampton,	40 59	72 16	6 8	1834	4.4	6 34	−22
New York City,	40 43	74 1	5 34	1840	3.6	5 34	+15
Flatbush,	40 40	73 59	4 57	1840	3.6	4 57	−22
Philadelphia,	39 57	75 11	3 52	1837	3.2	4 8	+14
West Chester,	39 57	75 39	3 25	1832	3.2	3 51	+20

Central position, latitude 42° 5′ N., longitude 75° 12′ W., $\delta = 2^\circ.0827$, i. e. $+5^\circ\ 5'.0$, $x = +.00930$, $y = +.01857$. Mean of the differences at the eight most northern stations $-3'.2$; nine southern $+2'.9$; four stations having greatest computed variation $+3'.7$; four least $+0'.7$; nine intermediate $-2'.0$.

TABLE IV.—19 *Stations.*

Station.	Latitude.	Longitude.	Variation.	Date.	Annual motion.	Variation 1840.	Differences.
	° ′	° ′	° ′		′	° ′	′
Mackinac,	45 51	84 41	−2 59	1827	+3.9	−2 8	+16
Huron Coast,	45 27	83 50	1 55	1840	4.0	1 55	−16
Michigan,	44 31	85 32	4 30	1838	3.9	4 22	−42
"	44 31	84 56	2 50	1838	3.9	2 42	+21
"	44 31	84 28	2 45	1838	3.9	2 37	− 5
"	44 31	83 50	2 0	1838	4.0	1 52	+ 2
Thunder Bay,	44 26	83 0	0 45	1840	4.0	0 45	+18
Pointe aux Barques,	43 51	82 42	1 38	1835	4.0	1 18	−24
Michigan,	43 51	83 6	2 6	1835	4.0	1 46	−27
"	43 45	84 22	2 55	1832	3.9	2 24	+17
Pere Marquette River,	43 44	85 43	4 34	1837	3.9	4 22	−16
Saginaw River,	43 36	83 50	2 19	1835	4.0	1 59	+10
	43 20	84 22	3 0	1832	3.9	−2 29	+19
Huron shore,	43 5	82 26	6	1835	4.0	+ 14	+63
	43 0	84 22	3 27	1831	3.9	−2 52	+ 2
Grand River,	42 55	86 10	4 30	1837	3.9	4 18	+32
Macomb County,	42 43	82 40	1 33	1839	4.0	1 29	−20
	42 30	84 22	4 25	1826	3.9	3 30	−28
Detroit,	42 24	82 58	1 56	1840	4.0	1 56	−22

Central position, latitude 43° 49′ N., longitude 84° 4′ W., $\delta = 2°.3429$, i. e. $-2° \, 20'.6$, $x = +.00472$, $y = +.02429$. Mean of the differences at the ten most northern stations $-4'.0$; nine southern $+4'.4$; five eastern $+2'.1$; four western $-1'.1$; ten intermediate $+0'.4$.

TABLE V.—16 *Stations.*

Station.	Latitude.	Longitude.	Variation.	Date.	Annual motion.	Variation 1840.	Differences.
	° ′	° ′	° ′		′	° ′	′
Buffalo,	42 52	79 6	+1 25	1837	4.1	+1 37	+ 1
Fairview,	42 5	80 25	0 0	1838	4 4	+0 9	−11
Chardon,	41 36	81 16	− 15	1838	4.4	−0 6	+23
Euclid,	41 33	81 35	−1 30	1825	4.4	0 24	+20
Cleveland,	41 31	81 45	19	1840	4.4	0 19	+34
Brookfield,	41 16	80 37	40	1837	4.2	27	−19
Braceville,	41 16	81 1	50	1838	4.2	42	−16
Hudson,	41 15	81 26	52	1840	4.2	52	− 7
Portage,	41 4	81 34	1 15	1838	4.3	1 6	−10
Wooster,	40 48	81 59	2 1	1837	4.4	1 48	−27
Carrolton,	40 36	81 10	30	1838	4.3	21	+28
Dover,	40 32	81 31	1 50	1838	4.3	1 41	−34
Coshocton,	40 18	81 55	1 30	1838	4.3	1 21	+ 9
Batesville,	39 56	81 17	1 22	1838	4.1	1 14	− 3
Marietta,	39 30	81 28	1 33	1838	4.3	−1 24	+ 6
Charlottesville,	38 2	78 30	0 0	1835	3.7	+0 19	+ 6

Central position, latitude 40° 53′ N., longitude 81° 2′ W., $\delta = °.60404$, i. e. $-36'.2$, $x = +.00676$, $y = +.01648$. Mean of the differences at the eight most northern stations $+3'.1$; eight most southern $-3'.1$; three most eastern $-1'.3$; four western $-3'.7$; nine intermediate $+2'.1$.

TABLE VI.—18 *Stations.*

Station.	Latitude.	Longitude.	Variation.	Date.	Annual motion.	Variation 1840.	Differences.
	° ′	° ′	° ′		′	° ′	′
Lower Sandusky,	41 22	83 10	−2 48	1838	+4.3	−2 39	+16
Flat Rock,	41 18	84 13	3 14	1838	3.9	3 6	+31
Kalida,	40 57	84 9	3 0	1838	3.9	2 52	+46
Logansport,	40 45	86 22	5 35	1836	2.7	5 24	−16
Marion,	40 34	83 9	3 17	1838	3.8	3 9	− 6
Zanesville,	39 59	82 1	2 30	1838	4.3	2 21	+ 3
New Madison,	39 54	84 36	4 51	1838	3.2	4 45	−37
Springfield,	39 52	83 45	4 30	1835	3 4	4 13	−39
Springbank,	39 45	83 45	3 14	1838	3.5	3 7	+28
Washington,	39 32	83 23	3 6	1838	3.4	2 59	+24
Springboro,	39 30	84 9	4 4	1838	3.1	3 58	− 4
Wilmington,	39 26	83 42	4 6	1838	3.3	3 59	−22
Athens,	39 23	82 4	3 12	1838	4.3	3 3	−31
Chillicothe,	39 21	82 55	3 15	1835	3.6	2 57	+11
Jackson,	39 13	82 38	3 10	1838	3.6	3 3	− 7
Cincinnati,	39 6	84 27	4 46	1840	3.1	4 46	−36
Gallipolis,	38 54	82 6	2 35	1838	3.7	2 28	+10
South Hanover,	38 44	85 30	4 35	1837	2.5	4 28	+29

Central position, lat. 39° 52′ N., lon. 83° 40′ W., $\delta = -1.5134$, i. e. $-3°\ 30'.8$, $x = +.00290$, $y = +.01441$. Mean of the differences at the eight most northern stations $-0'.2$; ten most southern $+0'.2$; four stations having the least computed variation $-0'.5$; six greatest $-3'.0$; eight intermediate $+2'.5$.

TABLE VII.—16 *Stations.*

Station.	Latitude.	Longitude.	Variation.	Date.	Annual motion.	Variation 1840.	Differences.
Goshen,	33°52′	82°39′	−5° 9′	1837	+2′.8	−5° 1′	− 1′
Lincolnton,	33 46	82 37	5 9	1837	2 .8	5 1	0
Applington,	33 32	82 28	5 0	1837	2 .7	4 52	+ 6
Augusta,	33 27	82 1	5 4	1837	2 .7	4 56	−19
Waynesboro,	33 4	82 9	5 4	1837	2 .7	4 56	− 3
Sandersville,	32 57	82 59	5 27	1838	2 .6	5 22	+18
Millhaven,	32 56	81 47	5 4	1837	2 .7	4 56	−20
Jacksonboro,	32 49	81 42	4 55	1837	2 .7	4 47	−12
Birdsville,	32 48	82 13	5 1	1837	2 .7	4 53	+10
Charleston,	32 42	80 4	2 54	1837	3 .3	2 44	+26
Swainsboro,	32 38	82 31	5 4	1838	2 .6	4 59	+24
Springfield,	32 20	81 31	5 5	1837	2 .7	4 57	−21
Savannah,	32 5	81 12	{ 5 5 3 31 }	1838 1839	2 .7	4 13	+12
Bryan C. H.	32 1	81 32	5 5	1838	2 .6	5 0	−16
Liberty C. H.	31 48	81 37	5 5	1838	2 .6	5 0	− 6
Darien,	31 26	81 37	5 5	1838	2 .6	5 0	+ 2

Central position, lat. 32° 46′ N., lon. 81° 55′ W., $\delta = -2°.78999$, i. e. $-4°\ 47'.4$, $x = +.006512$, $y = +.017627$. Mean of the differences at the six most northern stations $+0'.1$; ten most southern $-0'.1$; four most eastern $+0'.2$; three most western $+5'.7$; nine intermediate $-2'.0$.

TABLE VIII.—16 *Stations.*

Station.	Latitude.	Longitude.	Variation.	Date.	Annual motion.	Variation 1840.	Differences.
Toccoa Falls,	34°39′	83°30′	−5° 0′	1837	+2′.8	−4°52′	− 9′
Carnesville,	34 24	83 24	5 1	1837	2 .8	4 53	−12
Elberton,	34 6	83 0	4 33	1837	2 .8	4 25	+10
Athens,	33 59	83 32	4 31	1837	2 .6	4 23	+22
Lawrenceville,	33 57	84 11	5 0	1839	2 .4	4 58	− 1
Monroe,	33 50	83 52	5 10	1838	2 .4	5 5	−13
Madison,	33 34	83 40	4 29	1838	2 .4	4 24	+24
Eatonton,	33 20	83 33	4 32	1838	2 .4	4 27	+20
Milledgeville,	33 7	83 24	{ 5 51 4 40 }	1838 1835	2 .4	5 7	−22
Columbus,	32 28	85 11	5 30	1839	2 .0	5 28	− 8
Lumpkin,	32 9	84 55	5 27	1839	2 .0	5 25	− 9
Cuthbert,	31 49	85 2	5 30	1839	1 .9	5 28	− 9
Fort Gaines,	31 38	85 19	5 31	1839	1 .9	5 29	− 4
Bainbridge,	30 55	84 46	5 30	1839	1 .8	5 28	−12
Tallahassee,	30 26	84 27	5 12	1835	1 .8	5 3	+ 9
Pensacola,	30 24	87 23	6 0	1835	1 .4	5 53	+14

Central position lat. 32° 48′ N., lon. 84° 19′ W., $\delta=-1°.0443$, i. e. $-5° 2'.7$, $x=+.000795$, $y=+.006077$. Mean of the differences at the seven most northern stations, $+3'.0$; nine most southern, $-2'.3$; four stations having the greatest computed variation, $-1'.7$; five least, $-2'.2$; seven intermediate, $+2'.6$.

TABLE IX.—9 *Stations.*

Station.	Latitude.	Longitude.	Variation.	Date.	Annual motion.	Variation 1840.	Differences.
	° ′	° ′	° ′		′	° ′	′
Florence,	34 47	87 54	−6 28	1835	+1 8	−6 19	+34
Tuscaloosa,	33 12	87 43	7 28	1839	1 6	7 26	−32
Louisiana,	32 50	92 22	8 40	1835	1.6	8 32	−15
"	32 25	92 32	8 30	1836	1.6	8 24	− 3
"	31 50	92 32	8 30	1834	1 5	8 21	+ 2
"	31 45	92 22	8 30	1834	1.5	8 21	+ 1
"	31 40	92 32	8 40	1835	1.5	8 32	− 8
Mobile,	30 42	88 16	7 12	1835	1.4	7 5	+ 5
Louisiana,	29 40	94 0	8 41	1840	1.4	8 41	+16

Central position, latitude 32° 6′ N., longitude 91° 8′ W., $\delta=-1°.9581$, i. e. $-7° 57'.5$, $x=+.000911$, $y=+.005797$. Mean of the differences at five northern stations $-2'.8$; four southern $+3'.7$; two eastern $+1'.0$; three western $+1'.7$; four intermediate $-1'.7$.

TABLE X.—10 *Stations.*

Station.	Latitude.	Longitude.	Variation.	Date.	Annual motion.	Variation 1840.	Differences.
	° ′	° ′	° ′		′	° ′	′
Davenport,	41 28	90 18	−8 13	1840	+2 6	−8 13	− 9
Illinois,	41 10	88 32	7 25	1838	2 5	7 20	+ 2
"	41 0	88 32	6 50	1838	2.5	6 45	+36
"	40 50	88 32	7 43	1833	2.5	7 26	− 5
Jacksonville,	39 43	90 20	8 45	1833	2.5	8 28	−28
Alton,	38 51	90 15	{ 8 0 { 7 45	1835 } 1840 }	2.3	7 47	+ 8
St. Louis,	38 37	90 17	8 49	1835	2.3	8 37	−41
Missouri,	37 30	90 2	7 30	1827	2 1	7 3	+43
"	36 40	90 2	8 0	1825	2.0	7 30	+14
Nashville,	36 10	86 52	6 58.5	1832	2 0	6 42	−20

Central position, latitude 39° 12′ N., longitude 89° 22′ W., $\delta=-1°.58465$, i. e. $-7° 35'.1$, $x=-.000899$, $y=+.008730$. Mean of the differences at five northern stations $-0'.8$; five southern $+0'.8$; three having greatest computed variation $-9'.6$; three least $+3'.6$; four intermediate $+4'.5$.

TABLE XI.—27 *Stations.*

Station.	Latitude.	Longitude.	Variation.	Date.	Differ'nces
Prairie du Chien,	43° 3′	90° 53′	−9° 5′	1840	+ 8′
Madison,	43 3	89 11	7 30	"	+38
	43 3	89 42	8 20	"	+ 8
Campbell's,	43 1	89 26	8 48	"	−31
Blue Mounds,	43 0	89 36	8 38	"	−13
Trout Brook,	42 59	90 45	9 0	"	+ 7
Parish's,	42 58	90 10	8 55	"	−10
Mineral Point,	42 51	89 58	8 40	"	− 4
Turkey River,	42 42	90 48	9 0	"	+ 6
Log House,	42 38	90 43	9 0	"	+ 2
Sherald's Mound,	42 35	90 33	8 10	"	+45
Little Mahoqueta,	42 31	90 31	8 30	"	+23
Dubuque,	42 29	90 23	8 22	"	+25
Galena,	42 28	90 13	9 25	"	− 4
Sherwood's,	42 27	90 37	9 0	"	−30
North branch Mahoqueta,	42 23	90 52	9 35	"	−45
Whitewater,	42 18	90 38	9 10	"	−15
Mahoqueta,	42 14	90 57	8 45	"	+22
Farmer's Creek,	42 13	90 23	9 8	"	−24
Cheney's,	42 12	90 21	9 5	"	−23
Mill,	42 10	90 37	9 15	"	−23
Bridge,	42 6	91 2	9 20	"	−12
Small mill,	42 4	91 2	9 7	"	0
Elkford,	42 0	90 52	9 15	"	−15
Iron ore,	41 55	90 40	8 20	"	+31
Wapsipinnicon,	41 45	90 23	8 22	"	+16
Lost Grove,	41 39	90 9	8 10	"	+18

Central position, latitude 42° 28′ N., longitude 90° 25′ W., $\delta = -1^\circ.8046$, i. e. $-8^\circ\ 48'.3$, $x = -.00344$, $y = +.014564$. Mean of the differences at ten northern stations $+1'.1$; seventeen southern $-0'.7$; seven stations having the greatest computed variation $+0'.1$; six least $+2'.7$; fourteen intermediate $-1'.2$.

TABLE XII.—11 *Stations.*

Station.	Latitude.	Longitude.	Variation.	Date.	Differences.
Keweenaw Point,	47° 25′	88° 30′	−5° 37′	1840	− 1′
Riviere du Gres,	47 22	88 34	5 24	"	+15
Ontonagen River,	46 57	89 49	6 33	"	+17
La Pointe,	46 45	91 22	8 33	"	−10
Montreal River,	46 41	90 46	7 43	"	+ 3
Grand Marrais,	46 40	86 1	3 29	"	−35
Parisien Island,	46 32	84 38	1 11	"	+15
Miner's River,	46 32	86 35	3 39	"	−13
Sault St. Marie,	46 31	84 19	1 25	"	−19
Montreal Channel,	46 18	83 40	0 12	"	+10
Drummond Isle,	45 58	83 50	0 9	"	+18

Central position, latitude 46° 41′ N., longitude 87° 6′ W., $\delta=$ 4°.00489, i. e. $-4°\ 0'.3$, $x=-.003988$, $y=+.024886$. Mean of the differences at the six most northern stations $-1'.8$; five southern $+2'.2$; three most easterly $+3'.0$, three most westerly $+3'.3$; five intermediate $-3'.8$.

Collecting together the preceding results, we obtain the following table, in which column third represents the variation for places whose latitude and longitude are given in columns first and second; column fourth, shews the direction of the lines of equal variation; column fifth, the increase of variation in the normal direction for sixty geographical miles; and column sixth, the distance of the lines of equal variation expressed in geographical miles.

Latitude.	Longitude.	Variation.	Direction of lines.	Increase.	Distance of lines.
44°55′ N.	69°31′ W.	+13°13′.9	N. 50°40′ W.	118′.90	30.28
43 24	72 57	+ 8 26 .9	N. 39 13 W.	90 .29	39.87
42 5	75 12	+ 5 5 .0	N. 26 36 W.	74 .77	48.15
43 49	84 4	− 2 20 .6	N. 10 59 W.	89 .09	40.41
40 53	81 2	− 0 36 .2	N. 22 19 W.	64 .14	56.13
39 52	83 40	− 3 30 .8	N. 11 24 W.	52 .92	68.03
32 46	81 55	− 4 47 .4	N. 20 17 W.	67 .65	53.21
32 48	84 19	− 5 2 .7	N. 7 27 W.	22 .06	163.16
32 6	91 8	− 7 57 .5	N. 8 56 W.	21 .12	170.42
39 12	89 22	− 7 35 .1	N. 5 53 E.	31 .60	113.94
42 28	90 25	− 8 48 .3	N. 13 17 E.	53 .87	66.82
46 41	87 6	− 4 0 .3	N. 9 6 E.	90 .73	39.68

From these data are computed the positions of the following lines of equal variation.

Variation.	Lat.	Lon.	Direction.	Variation.	Lat.	Lon.	Direction.
+14°	45°25′.1	69°31′	N. 52°30′ W.	−3°	39°52′	82°53′.6	N. 13°35′ W.
13	44 45 .9	69 31	N. 50 7 W.	4	46 41	87 5 .4	N. 9 6 E.
9	43 24	72 18 .0	N. 41 17 W.	4	39 52	84 24 .0	N. 9 20 W.
8	43 24	73 28 .8	N. 37 32 W.	4	32 46	81 1 .7	N. 20 17 W.
6	42 5	74 5 .4	N. 27 17 W.	5	32 48	84 10 .3	N. 7 26 W.
+ 5	42 5	75 18 .0	N. 26 32 W.	8	32 6	91 17 .0	N. 8 57 W.
− 2	43 49	83 44 .4	N. 12 16 W.	7	39 12	87 55 .6	N. 3 24 E.
3	43 49	84 41 .5	N. 8 31 W.	8	39 12	90 23 .4	N. 7 39 E.
0	40 53	80 13 .5	N. 24 35 W.	8	42 28	89 10 .1	N. 10 16 E.
1	40 53	81 33 .8	N. 20 50 W.	9	42 28	90 43 .2	N. 14 1 E.

The preceding positions are each determined from a single group of observations, independently of all the others. In projecting the lines upon a map, some anomalies will be perceived as to the direction of the lines and their distance from each other. The most remarkable of these is the line $-4°$ in latitude 32° 46′. The

observations at some distance from this line would lead us to look for it about three quarters of a degree farther west than the position here assigned.

P. S. *Seventeen hundred Errata in Hutton's Table of Products.*

In solving equations of condition by the method of minimum squares, I have been accustomed to form the products by the aid of Hutton's Table. I entertained no doubt of its accuracy, until, on verifying one of my operations, I discovered in the Table an error which I presently perceived to run through almost an entire folio page. The case occurs on page 20, the product of 361 by 15 being given 5315 instead of 5415, and as the products appear to have been derived from each other by addition, this error is propagated to the bottom of the page, affecting thus 1700 products.

Art. X.—*On the Want of Identity between Microlite and Pyrochlore;* by Charles Upham Shepard, M. D., Prof. Chem. in the Medical College of the State of South Carolina.

Prof. Silliman having apprised me on my recent arrival in town, that a paper was about to appear in this Journal by Messrs. Teschemacher and Hayes of Boston, the object of which would be to establish the identity of Microlite with Pyrochlore, and being permitted by the editors, I hasten to reply in the same number.

The opinion of the identity originated with Mr. Teschemacher; and is expressed without the slightest reserve, resulting as he remarks, "from a close examination of several crystals of the mineral named Microlite;" but Mr. T. singularly enough omits altogether, the results of any researches bearing on the point to be established, if we except the mention of a mineralogical property which is simply descriptive, never characteristic, viz. the circumstance that in Microlite, the color is "transparent (!) straw-yellow to brick-red and dark brown!"* For the full confirmation of his opinion, he then refers to the analysis of Mr. Hayes, which was undertaken at the request of the Chemical Society of Boston.

* In this account of color however, my specimens do not agree.

I shall first exhibit the mineralogical differences between the two minerals, in order to show the fallacy of any attempt to unite the two species on natural-history grounds; and shall then inquire what support the new view acquires from chemistry.

Pyrochlore.	*Microlite.*
Crystals, unmodified regular octahedrons.	Crystals, regular octahedron, with edges truncated and angles surmounted by four-sided pyramids, whose faces correspond to the octahedral planes.
Cleavage, none (fracture conchoidal).	Cleavage, octahedral, distinct.
Lustre, resinous to vitreous.	Lustre, resinous.
Color, deep red-brown to black.	Color, pale honey-yellow. Surfaces of crystals often reddish or blackish brown from implanted minerals.
Streak, brown.	Streak, pale yellowish white.
Translucent on the edges, to opake.	Semi-transparent to translucent.
Hardness=4.75.	Hardness, 5.25 (readily scratches Pyrochlore).
Gravity=4.20 to 4.25.	Gravity =5.485 to 5.562.*

I consider it apparent therefore, that all attempts to unite two minerals, whose individuals afford no transition-links to constitute the passage of insensible gradation, in properties so essential as specific gravity, internal structure and hardness, must prove una-

* The specific gravity as heretofore quoted, was 4.75 to 5.00; but very opportunely for this examination, I had brought with me from my Charleston cabinet an excellent crystal, weighing 3.805 grains; and possessing one of Robinson's best eight inch-beam balances (which turns readily with one thousandth of a grain), I was able to correct the specific gravity, as above. The original determination of this property was effected by means of a balance much less sensitive, and on a crystal whose weight was only four tenths of a grain. Indeed, this was the largest crystal I had seen, when I described the species. Observing however, that my crystal of 3.805 grains had two of its octahedral sides pitted from the implantation of calcareous spar and green tourmaline, I at first took its specific gravity with these impurities attached. The result was 5.485. I then cleaved off these faces, thereby reducing the weight of the crystal to 2.410 grains, when its gravity rose to 5.562.

vailing; and according to the rules of forming the species in mineralogy, Microlite must still stand distinct from Pyrochlore.

Let us now turn to a review of the analysis of Mr. HAYES. This gentleman has not in any form, alluded to a paper of mine, entitled "*Chemical Examination of Microlite*," and published in Vol. XXXII, p. 338, of this Journal. To save the reader the trouble of referring to that article, I will simply quote from it so far as to say, that I found the Microlite to be a columbate of lime and yttria, with moisture and traces of uranium and tungstic acid. The details of the examination were fully given in that communication; and in particular, the proofs that the mineral was a *columbate*. My surprise was therefore not inconsiderable, to find the subject of my former labors held up in a light so novel, as that of being a salt of a totally new and non-isomorphic genus.

The paper of Mr. HAYES in support of his views, is out of proportion full on points, where the evidence is unsatisfactory; and silent, where the reader might appreciate its value as affecting the point at issue: for I hold the blowpipe characters of complex bodies like the Microlite to be simply sufficient for furnishing the chemist to tolerable guesses, in aid of subsequent and more certain experiments with chemical reagents, upon the decomposed and separated ingredients of the mineral. After nearly a page of blowpipe results, many, if not all, of which would be likely, in other hands (with different lamps, blowpipes, and lungs, as well as different sized specimens and proportions of fluxes), to be afforded from specimens of half a dozen other species as well as from Microlite, we have the steps of the analysis given in the following words. "One grain of the mineral which had been dried was decomposed; the titanic acid carefully separated and dried, it weighed 80; this had the chemical characters of pure titanic acid.

"The solution of the oxides from the titanic acid gave a precipitate of sulphate of tin, when treated with sulphohydric acid, and the sulphate* oxidized before the blowpipe gave with soda a globule of tin. Sulphohydrate of ammonia gave a black precipitate, which when roasted contained oxides of iron and uranium, with traces of oxide of cerium. The fluid remaining gave

* The sulphuret of tin is here referred to, by Mr. HAYES, in this as well as in the previous line.

with oxalate of ammonia, a precipitate which was converted into sulphate of lime, equivalent to 0.08 lime. Thus,

Titanic acid, ...	80.
Oxide of tin, iron, cerium, uranium, ...	11.8
Lime, ...	08.2
	100.0

"This mineral is therefore identical with that analyzed by Wöhler. The absence of protoxide of manganese and water, and the smaller proportion of oxide of iron in this specimen, as indicated by the blowpipe experiments, will account for the larger proportion of titanic acid given in the analysis." p. 34.

Then follows a quotation of the analysis of Pyrochlore by Wöhler, with which Mr. Hayes identifies his own results upon the Microlite. But when we find, on comparing the two analyses, a difference of more than 17 per cent. in the acid, and of one third in the principal base, as well as a wide discrepancy in volatile matter, and call to mind that these results are deduced from a single trial, and that upon one grain's weight of the mineral, we must believe, that the conclusion of Mr. Hayes cannot be sustained upon such slender grounds; and inasmuch as Mr. Teschemacher refers to the analysis for the confirmation of his views, is it not possible that Mr. H. in turn, has unconsciously been indebted to the mineralogical evidence for a portion of his confidence?

In order to speak from present knowledge on the subject, although I have no reason to doubt the correctness of former results, I subjected 2.142 grains of the above mentioned crystal to the following examination; premising however, that my inquiry was chiefly directed to the proofs of columbic acid in the mineral, and not to a rigid determination of proportions in the different constituents.

A. The powdered mineral was white, with only a faint tinge of yellow. Heated for half an hour to redness, it scarcely changed in color; and lost 0.060 in weight, which equals 2.801 per cent. It was then intimately mixed with six times its weight of bisulphate of potash, and the mixture maintained in fusion for half an hour. Successive portions of water were boiled upon the

fused mass for upwards of half an hour, until every thing soluble was taken into solution. A dense, white powder remained undissolved.

B. Hydrosulphate of ammonia produced, in a portion of the solution A, a precipitate, without sensible discoloration, and which, from former proofs in my paper of 1835, was taken for yttria. The remainder of the fluid was then precipitated by oxalate of ammonia, the precipitate ignited, redissolved in hydrochloric acid, the yttria thrown down by ammonia, and the lime by oxalate of ammonia, which on ignition, weighed 0.032 or 1.49 per cent.*

C. The white, insoluble matter A, was digested for some time in a saturated solution of hydrosulphate of ammonia, the operation being conducted on a filter in the way recommended by Berzelius. The insoluble matter was blackened by the affusion of the hydrosulphate.

D. The sulphohydric fluid was decomposed by nitric acid and heat; hydrochloric acid was added; no precipitation ensued. But the fluid, on the addition of ammonia, afforded a precipitate of peroxide of tin, which after ignition, weighed .001, which equals 0.047 per cent. The oxide was reduced with carbonate of soda on charcoal, to the metallic state.

E. The blackened powder C was treated with dilute hydrochloric acid, and gently warmed. The filtered solution was precipitated by ammonia, and ignited. The peroxide of iron was apparently blended with traces of yttria. It weighed 0.022 or about 1 per cent.

F. The insoluble matter, washed by hydrochloric acid (E) was drenched upon the filter, with an abundance of hot water: it showed no tendency to pass through the filter in a milky state, as titanic acid is well known to do, under such circumstances. It was ignited in a platina crucible, and exhibited *a white color while hot*, as well as after cooling. Its weight after some accidental losses, was 1.052 gr.=49.11 per cent. But I still regard my former determination of the proportion of acid, and which was 75.70 per cent., to be very near the truth.

* The calcareous content here obtained is quoted only as an approximation; but falling so much below what I previously found, and considered in conjunction with my observation of implanted calcareous spar upon the crystal, it is possible that lime may yet prove to be an accidental ingredient in the mineral.

A portion of the acid was fused with carbonate of potash in a platina crucible; water was boiled upon the mass, whereby *a complete solution was effected.* To a portion of the solution, hydrochloric acid was added. It first occasioned a cloudiness, *but subsequently the fluid became clear. The same effect was produced by oxalic acid.* Ferrocyanide of potassium afforded with the oxalic solution, *a yellow precipitate,* and the tincture of nut-galls with the same, a rich *orange precipitate.*

A portion of the acid was fused with biphosphate of soda on a platina hook, in the inner flame of the blowpipe: a transparent glass was obtained, which was *colorless while hot, as well as after cooling.* Fused with soda before the blowpipe, an opake, white bead was obtained.

My conclusion concerning the composition of the Microlite, derived from the foregoing examination, coupled with that in 1837, is this, that it is a columbate of yttria and lime, with a little moisture, adventitious traces of iron, tin, tungstic acid, and uranium.

I do not possess enough of the mineral to enable me to undertake its analysis: but it is a question which I regard with interest, and shall welcome its final settlement from whatever quarter it comes; though I must be excused, in the face of such evidence as I have already cited, from acquiescing in the mere declaration of any authority however high, that its prime ingredient is titanic, in place of columbic, acid.

To show that a zeal to defend a species because it was put forth by myself, is not the motive for the present reclamation, I am free to say, that I have long perceived several striking analogies which point towards an identity between Microlite and the Yellow yttro-tantalite of Ytterby, although "a close examination" of several points in the history of the latter substance, yet requires to be made, in order to establish the truth of such a conjecture.

New Haven, May 15, 1842.

The remarks of Prof. Shepard having been communicated to Mr. A. A. Hayes, he candidly admits their correctness.—Eds.

Art. XI.—*Additional Objections to Redfield's Theory of Storms;* by Robert Hare, M. D., Professor of Chemistry in the University of Pennsylvania.

33. In a communication to the American Journal of Science, for January, I endeavored to point out various errors and inconsistencies, in the theory of storms proposed by Mr. Redfield, or in the reasoning and assumed scientific principles on which that theory had been advanced. Of these errors I will present a brief summary.

34. I conceive that Mr. Redfield has erred, in ascribing atmospheric currents, whether constituting trade winds or storms of any kind, "*solely to mechanical gravitation as connected with the rotatory and orbitual motion of the earth.*"*

35. In ascribing those atmospheric gyrations of which according to his hypothesis all storms consist to "*opposing and unequal forces,*" without specifying the nature or accounting for the existence of these forces, although implying that they originate as above mentioned.

36. In assigning to all fluid matter a tendency to "*run into whirls and circuits, when subjected to opposing and unequal forces,*" when this allegation, if true at all, can only be so in some peculiar cases of such forces.

37. In alleging all storms to be whirlwinds, and yet representing a "*rotative movement in air as the only cause of destructive winds and tempests,*" *so that a whirl is the only cause of a whirlwind.*†

38. In averring, in reference to the alleged gyration and vortical force of tornadoes which are by him treated as hurricanes in miniature, that "*all narrow and violent vortices have a spiral involute motion quickening in its gyration as it approaches the centre or axis of the whirl,*" whereas it must be evident that when gyration in a fluid does not result from a contemporaneous centripetal force, arising from an ascending or descending current at the

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* See paragraph 43 of this essay.

† This Journal, Vol. xxi, p. 192: *Storms and hurricanes consist in the regular gyratory motion or action of a progressive body of atmosphere, which action is the sole cause of the violence which they may exhibit.*

If we understand Mr. Redfield, he assigns the whirlwind as the cause of the "violence"—not as the cause of the "whirlwind"—the two words not being synonymous.—Eds.

axis, but on the contrary exists only in consequence of a momentum previously acquired, the consequent velocity in any part of the mass affected, will be less in proportion to its proximity to the axis: also that the only case in which it can increase with its proximity, is where the mass is fluid and it proceeds from some competent cause acting at the axis.

39. In representing that the upward force of tornadoes is the *effect* of a vortical or gyratory action,* when it must be quite plain that a "*vortical*" action or whirling motion instead of causing the air upon the terrestrial surface, necessarily subjected by it to a centrifugal force, to seek the centre, would induce that portion of the atmosphere which should be above the sphere of the gyration, to descend into the central space rarefied by the centrifugal force.

40. In admitting the gyration, which he considers as the cause of storms, to quicken as it approaches the axis of motion, without perceiving that this characteristic is irreconcilable with his inference that gyration caused by forces acting remotely from the axis is the proximate cause of all the phenomena in question.

41. In the last number of the American Journal of Science, (for April, 1842,) Mr. Redfield has hinted that the pains which I have taken to confute his doctrines, are disproportioned to the low estimation in which I have professed to hold them. I should be glad if this view of the subject should render my strictures agreeable to him; and am sincerely sorry that, consistently with truth, I cannot directly take a course more favorable to his meteorological reputation. I admit that his essays have met with an attention which may have justified him in pluming himself on their success. Had it been otherwise, I should not have thought it worth while to enter the lists. It strikes me, however, that a fault now prevails which is the opposite of that which Bacon has been applauded for correcting. Instead of the extreme of entertaining plausible theories having no adequate foundation in observation or experiment, some men of science of the present time are prone to lend a favorable ear to any hypothesis, however in itself absurd, provided it be *associated with observations.* But to proceed with the "reply," so called, the author alleges that in the absence of "*reliable facts and observations*" in support of my

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* See paragraph 75 of this communication.

objections to what he considers as the "*established character of storms*," he had hesitated to answer them. This cannot excite surprise, when it is recollected "that the whole modern meteorological school," and likewise "Sir John Herschel," are accused by him of a "*grand error*," in not ascribing all atmospheric winds "*solely to the gravitating power as connected with the rotary and orbitual motion of the earth*."

42. For this denunciation he has no better ground than that on which he deems his theory to be above my reach, that is to say, because himself and others have made some observations shewing that in certain storms, agreeably to log-book records, certain ships have had the wind in a way to indicate gyration. Being under the impression, that in many instances no better answer need be given to Mr. Redfield's opinions than that created in the minds of scientific readers by his own language, I will here quote his denunciation of the opinions of the meteorological school and of Herschel.

43. "*The grand error into which the whole school of meteorologists appear to have fallen, consists in ascribing to heat and rarefaction the origin and support of the great atmospheric currents which are found to prevail over a great portion of the globe.*" * * * "*An adequate and undeniable cause for the production of the phenomena* * * *I consider is furnished in the rotative motion of the earth upon its axis, in which originate the centrifugal and other modifying influences of the gravitating power, which must always operate upon the great oceans of fluid and aërial matter, which rest upon the earth's crust, producing of necessity those great currents to which we have alluded.*" (See this Journal, Vol. XXVIII, p. 316.) Speaking of Sir John Herschel's explanation of the trade winds and others, Mr. Redfield alleges, "*Sir John has however erred, like his predecessors, in ascribing mainly, if not primarily, to heat and rarefaction those results which should have been ascribed solely to mechanical gravitation as connected with the rotative and orbitual motion of the earth's surface.*"

44. Is it not surprising that it did not occur to the author of these remarks, that an astronomer so eminent as Sir John Herschel would be less likely than himself to be ignorant of any atmospheric influence resulting from gravitation or the diurnal and annual revolutions of our planet—and that when he found him-

self in opposition to the whole school of meteorologists, a doubt did not arise whether the "*grand error*" was not in his views of the subject instead of that which they had taken?

45. It seems to have been forgotten, that all the aqueous portion of the terrestrial surface being, no less than the superincumbent atmosphere, subjected to the gravitating power and the rotary and orbitual motions of our planet, no impulse can be given to the one which is not received by the other; and that as the heavier the fluid the greater the influence, if this be competent to create gales in the atmosphere, it must be no less competent to produce torrents in the ocean. Moreover, do not his opinions conflict not only with the *whole school of meteorologists*, but also with a portion of the modern school of geology? Agreeably to the last mentioned school, the external portion of the earth consists of a comparatively thin shell of earth and water floating upon an ocean of matter kept in fusion by heat; the oblate spheroidal form of our planet being due to the perfect equilibrium of the "*gravitating, rotary, and orbitual*" forces which are most inconsistently represented by Mr. Redfield, as having upon the atmosphere an opposite effect.

46. But notwithstanding the opinions expressed in the paragraphs above quoted, and in the following, Mr. Redfield alleges in his reply to my objections that it is an error to consider him as rejecting the influence of heat. It is very possible that his opinions may have changed since he read my "*objections*;" but that he did reject the influence of heat when the preceding and following opinions were published must be quite evident. "*Were it possible to preserve the atmosphere in a uniform temperature all over the surface of the globe, the general winds would not be less brisk than at present, but would be more constant and uniform than ever.*" (This Journal, Vol. XXVIII, p. 318.)

47. Mr. Redfield alleges that the proper enquiry is, *What are storms?* not *How are storms produced?* And yet it will be found that his great object has been to show that they arise from gyration caused by unequal forces generated in some inexplicable mode, by gravitation and the complicated motions of our planet. But suppose that before ascertaining *how* fire is produced, chemists had waited for an answer to the question *what is fire*, how much had science been retarded? I do not therefore blame Mr. Redfield for pursuing both inquiries simultaneously,

inconsistently with his own rule above stated, but I am astonished that he should, without any new experiments or any demonstrations, by an *ipse dixit* undertake to make a novel application of the gravitating power, and the forces arising from the earth's motion; and to inform one of the most eminent astronomers of the age that he had committed an error in overlooking their all-important meteorological influence.

48. Turning from an endless controversy with a writer with whom I differ respecting first principles, I shall address myself to that great school of meteorologists who concur with me in the "*grand error*" of considering heat and electricity as the principal agents of nature in the production of storms, and who do not concur with Mr. Redfield in considering gravitation and the earth's annual and diurnal motion as the great destroyer of atmospheric equilibrium. So far as it may conduce to truth, I shall incidentally notice some parts of Mr. Redfield's reply; but my main object will be to show the inconsistency of his theoretic inferences with the laws of nature, and the facts and observations on which those inferences are alleged to be founded. To follow him in detail through all the misunderstandings which have arisen, and which would inevitably arise during a continued controversy, would be an Ixion task.

49. Speaking of the trade winds and monsoons, our author states: "*It is to the operation and effect of these great and regular moving masses,*" that we are disposed mainly to ascribe the more active and striking meteorological phenomena of every latitude. * * And again, "*At these seasons the northern margin or parallels of the trade winds sweeping towards the gulf, must necessarily come in collision with the great archipelago of islands which skirt the Carribean Sea,*" * * * (this Journal, Vol. xx, p. 31,) "*the obstruction which they afford produces a constant tendency to circular evolution.*" * * * "*These masses of atmosphere thus set into active revolution continue to sweep along the islands with increased rapidity of gyration until they impinge upon the American coast.*" "*We have assumed that the leading storms of the northern and western Atlantic and the American coast originate in detached and gyrating portions of the northern margin of the trade winds, occasioned by the oblique obstruction which is opposed by the islands to the direct progress of this part of the trade, or to the falling of the northerly and eddy wind*

upon the trade, or to these causes combined." (This Journal, Vol. xx, p. 48.)

50. I trust it will be sufficiently evident, that although great and regularly moving masses of air, by encountering obstructions, may undergo a transient deflection, and that a portion accidentally caught in a strait with high cliffs on either side might like the tide in the Bay of Fundy, acquire a local and temporary acceleration, yet that it would be utterly impossible for a durable whirlwind to be thus excited. Obviously for the endurance of a whirl, if not for its production, the continuous application of at least two forces would be requisite, of which one must be endowed with a centripetal efficacy in order to counteract the concomitant centrifugal momentum. It will be evident that although a local obstruction may cause an eddy or whirl in its vicinity, the rotary momentum thus created must soon be exhausted. But admitting that a blast by being deflected by an island could become a permanent whirlwind, obviously the resulting velocity could not be so great as that of the generating current. The moderately blowing trade wind could not, by contact with an inert body, acquire an increase of velocity adequate to form a furious hurricane capable, as represented, of travelling circuitously for more than two thousand miles.

51. The hurricane once created, agreeably to the imagination of Mr. Redfield, its subsequent progress is described in the following language: "*This progress still continues while the stormy mass is revolving around its own moving axis; and we can readily comprehend the violent effects of its unresisted rotation, while this velocity becomes accelerated by nearly all the oblique forces and perhaps resistances of the circumjacent currents or masses of moving atmosphere. These storms cover, at the same moment of time, an extent of contiguous surface, the diameter of which may vary from one to five hundred miles, and in some cases have been much more extensive. They act with diminished violence towards the exterior, and with increased energy towards the interior of the space which they occupy.*" (This Journal, Vol. xxv, p. 114.)

52. Thus it is assumed, that a mass of air from "*one to five hundred miles in diameter*" being made to whirl with the velocity of a most furious gale, is not only "*unresisted*" by the waves, forests, hills, and mountains, which it may encounter, but is actually "*accelerated by nearly all the oblique forces and perhaps* RESIS-

TANCES" which it may meet. Yet it must be quite clear, that any reaction with currents not moving the same way, or moving with an inferior velocity, or obliquely, could only be productive of retardation.

53. The following inconsistencies will shew how far Mr. Redfield's account of the phenomena of storms is to be deemed sufficently accurate or consistent to overset the established principles of science.

54. "*The rotation of a continued whirlwind involves not only changes in the position and condition of its constituent particles, but a constant accession of the exterior atmosphere to the body of the whirlwind, together with a discharge equally constant spirally at one extremity of its axis of rotation.*" (Franklin Journal, Vol. 19, p. 122.) Ibid., p. 120: "*Nor is it my intention to deny any movement or upward tendency at the centre of a whirlwind storm, for of such a movement, apart from theory, I have long since obtained good evidence.*" Ibid., p. 122: "*In regard to the depression of the barometer which I have ascribed to the rotary action of whirlwind storms, Mr. Espy has himself shewn, that the centrifugal action in a storm which gyrates horizontally must tend to withdraw or rarefy the air at the centre by causing a transfer or accumulation towards the exterior of the storm, thus causing a higher state of the barometer around the exterior border, than at the centre of the gale. This connexion and result is in strict accordance with the facts of the case as exhibited in all storms of this character so far as my observations and information extend.*"

55. On opposite sides of the same leaf we find the preceding quotations. Agreeably to the first, there is a constant accession of air from the exterior atmosphere to the body of a whirlwind, attended by an upward force and compensated by a discharge at one extremity of its axis of rotation; agreeably to the last, the centrifugal action tends to withdraw the air of the centre by causing a transfer or accumulation towards the exterior border.

56. In tornadoes the author admits the undeniable existence of an ascending column at the axis (75), and we are told that a whirlwind storm "*operates in the same manner and exhibits the same general characteristics as a tornado;*"* but this idea is evi-

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* This Journal, Vol. xxv, p. 117.

dently irreconcilable with that of a withdrawal of air from the centre, agreeably to one of the contradictory allegations above cited.

57. Nor are the following observations more consistent. "*During the passage of these eddies or storms over the place of observation the barometer sinks while under their first or more advanced portions and rises as they pass over or recede.*" (This Journal, Vol. xxv, p. 129.) "*The barometer, whether in higher or lower latitudes, always sinks while under the first portion or moiety on every part of its track excepting perhaps its extreme northern margin.*" "*The mercury in the barometer always rises again during the last portion of the gale and commonly attains the maximum of its elevation on the entire departure of the storm.*"

58. But if "*a higher state of the barometer be created around the exterior border of a whirlwind than at the centre,*" and if of necessity the exterior border be first encountered, how does it happen that precisely about this space, agreeably to the statement last quoted, the barometrical column should sink? And if, agreeably to the statement quoted previously, the air be rarefied about the centre and accumulated towards the border, in passing from the one border to the other through the centre, would not the mercury in the barometer first rise, then sink, and afterwards rise again, instead of falling during its exposure to one moiety of the storm, and rising during exposure to the other?

59. It may be presumed, that respecting the state of the barometer and the movement of the air, within the sphere of his whirlwinds, Mr. Redfield's views are not in accordance with any settled notions. His theory leads to the idea of a centrifugal force, rarefying and removing the air from the centre, while his observation of the ascending current in tornadoes has tended to create an opposite impression.

60. Considering the inconsistencies of Mr. Redfield's "*reliable* facts and observations," I hope I may be allowed to show what ought to ensue according to his own premises. Evidently in a whirlwind, constituted as are those to which we have reference, the centrifugal force will cause an accumulation of air towards the exterior until the otherwise uncounteracted pressure of the accumulation, tending to restore the level, is in equilibrio with the centrifugal force. Moreover, the reaction of the fluid lying in the same plane beyond the whirl, will cause the fluid to be

higher, or if elastic, denser at an intermediate point than the general level. In the case of an elastic fluid like the air, condensation will be substituted for accumulation, and will amount to the same thing in effect. It would follow, that as the whirl should advance, the barometer would rise until the front limb of the zone of greatest condensation should arrive: subsequently it would fall till the central space should arrive, and then another rise and subsequent fall would ensue during the approach and departure of the rear limb of the zone of greatest condensation.

61. One fact is mentioned among the contradictory evidence above quoted, which seems to be supported by universal experience. The barometrical column does fall at the commencement of a storm, and of course this fact does not accord with the idea that storms are whirlwinds produced by mechanical forces remote from the axis and attended necessarily by a centrifugal action which would accumulate the air towards the exterior.

62. Respecting another characteristic, the "*reliable facts and observations of our theorist,*" are no less irreconcilable than in the case last considered. I allude to the changes in the direction of the wind which ensue from the commencement to the end of a hurricane, and especially on the outer limbs on each side of the line of progression.

63. Thus speaking of the progress of a storm from southwest to northeast along the coast of the United States, he alleges that "*along the central portions of the track the first force of the wind is from a point near southeast, but after blowing for a certain period it changes* SUDDENLY, *and* USUALLY, AFTER A SHORT INTERMISSION, *to a point nearly or directly opposite to that from which it has previously been blowing; from which opposite quarter it blows with equal violence till the storm has passed over or abated.*" Again, "*It is demonstrably evident, that at any point over which the centre of a whirlwind may pass, the wind must* SUDDENLY *change to a direction almost exactly opposite to that which has been felt during the preceding part of its progress.*" (This Journal, Vol. xx, p. 22.) "*It sometimes happens when the central portion of an extensive storm passes over or near the point of observation that the comparative calm or lull which prevails about the apparent centre of rotation*, is preceded by a gradual rather than a sudden abatement of the wind. "*Every experienced navigator will shrink with instinctive apprehension from*

the very idea of those moments of awful stillness which place him in the central vortex of the hurricane." (Franklin Journal, Vol. xix, p. 116, and this Journal, Vol. xx, p. 47.)

64. Amid the neutralization of evidence which inevitably results from the conflicting statements above quoted, I will endeavor to point out the results which ought to ensue if the inferences of the advocates of the whirlwind doctrine were correct.

65. When a rotary motion is communicated to a solid by a force applied to any part whatever, the tangential velocity at any point will be directly as its distance from the centre. In a fluid, when the force productive of rotation is applied at any point remote from the axis, the motion at the axis can be no quicker than in the case of a solid, but may be slower, since the parts do not of necessity move simultaneously. In the case of a fluid body kept in motion by a momentum resulting from forces previously applied, as in the instance of a Redfield whirlwind, any zone, which has been made to revolve by the direct application of force, will be retarded until it causes, in the adjoining zones, a due proportionable velocity. This will not be attained until the whole rotates like a solid. There is however this difference, that the external portions of the whirling zone being pressed by the centrifugal force against other portions of the same fluid, the one will conflict with the other, so as to cause the velocity to be communicated and to lessen outwards from the zone (in which the moving power is or has been applied) till it becomes insensible. This result must ensue the more speedily, since the momentum receives no reinforcement, while the mass which it actuates increases with the square of the distance from the axis.

66. It follows that at any station over which, or near which the centre of a whirlwind shall pass, there will be a breeze scarcely perceptible at first, but which will strengthen gradually into a gale of preëminent fury. Subsequently a declension must take place until the centre arrives; here again there would be no perceptible wind. The centre having moved away, the wind must increase again to a maximum of force and then decline to a breeze.

67. Mr. Redfield alleges, that the storm of August 17th, 1830, whirling to the left, travelled from southwest to northeast at the rate nearly of twenty seven miles per hour; that its greatest diameter was from five hundred to six hundred miles; that of its

severe part was from one hundred and fifty to two hundred and fifty miles. Thus it may be assumed, that in order for an observer to be exposed successively within the severe portion on the southeastern and northwestern limbs, the storm would have had to move at least one hundred miles, requiring nearly four hours. Hence if the storm in question were a whirlwind, instead of the change having been sudden, several hours would have been required for its gradual accomplishment.

68. To prove therefore that a sudden change ensued from one violent wind to another of the same character blowing in an opposite direction, is to demonstrate that the storm in which it took place was not an extensive whirlwind. Yet this characteristic is universally admitted to belong to hurricanes, and especially to those upon our territory in which a southeaster is followed by a northwester. Hence the seaman's saying which Mr. Redfield sanctions in quoting, "*a northwester does not remain long in debt to a southeaster.*"

69. But if the storm above alluded to moved from southwest to northeast as Mr. Redfield's doctrine requires, and the velocity of the wind on the southeastern and northwestern limbs of the whirl were as great as described, that on the southwestern side must have been more than a fourth more violent, having the general motion of the storm, superadded to its appropriate gyrating velocity. Yet there is no evidence that any such superiority existed. On the contrary the violence of the southeaster and northwester seems to have been preëminently the object of attention.

70. Agreeably to Mr. Redfield, hurricanes have a diameter varying from one mile to five hundred miles, the diameter of the severe part of the storm of August, 1830, being from one hundred and fifty to two hundred and fifty miles. Of course a portion of the eastern as well as the western limb of such a storm might be comprised between the Alleghany mountains and the Atlantic shore; and in no case would the inner portion of the southeastern and more violent limb be beyond the cognizance of our merchants and insurers. It would be a matter of course that in every violent northeast gale, arising as represented from the progression of the northwestern limb along our coast, fears would be entertained lest vessels, inward bound, should be met by a much more violent southwester. But experience shews, that every

northeaster brings in a crowd of vessels having only to complain of the violence not of the direction of the wind.

71. It has been assumed, that a storm whirling to the left and travelling northeasterly, must, at stations passing nearly under the centre, first blow as a southeaster and afterwards gradually change to a northwester. Meanwhile on the southeastern or left limb it will blow only from the southwest, and on the northwestern or right limb it will blow only from the northwest. Consistently, when the storm travels from southeast to northwest, as hurricanes are represented to travel in proceeding from the sphere of their origin in the West Indies to the coast of North America, it will at stations within a certain distance of a line described by the centre, blow from the northeast first. On the southwestern limb it will blow first as a northwester; on the northeastern limb as a southeaster. Moreover, that on the last mentioned limb the greatest violence will occur, since the general motion of the whirlwind will there coöperate with that of the whirl. Yet in the following paragraph Mr. Redfield informs us, (this Journal, Vol. xxv, p. 128,) that "*In the West Indies, hurricanes begin to blow from a northern quarter of the horizon, and then changing to west and round to a southern quarter and then their fury is over.*"

72. This account of the direction of the wind in West India hurricanes agrees with that quoted by Espy from Edwards's History of Jamaica, Vol. 3d: "*All hurricanes begin from the north, veer back to west-northwest, west, and south-southwest, and when got to southeast, the foul weather breaks up.*"

73. It must be evident, as stated among my "*objections*," that when a whirl is first originated, whether it describe a helix, *as would result from its progressive circular motion, or a circle, as represented by Mr. Redfield in his charts*,* it must at thirty two stations equidistant from each other and the centre of gyration, blow from as many points of the compass. However, when once *under way*, it being granted that the whirling is always from right to left, evidently at any station near the line described by the centre, it will begin to blow at right angles to that line or from the northeast. As the centre advances this wind would gradually subside, and, after the centre should have gone by, it would begin to blow from the southwest with increasing force till the se-

* Franklin Journal, Vol. 19, p. 120.

vere part of the southeastern limb should be passed. On this part of the track only one change would take place. But at two stations sufficiently remote from the central line, the wind in passing from northeast to southeast would undergo an intermediate deviation, but necessarily of an opposite nature, since for the same reason that at one, there would be first more northing and then more westing, at the other, there would be more easting and more southing, *pari passu.* But on the outward northeastern and northwestern limbs, or in other words, on the right and on the left external borders, there would be no change. On the one it would blow from the northwest only, on the other only from the southeast. On this last mentioned limb the blast would be preëminent in violence, since in that direction the gyrative and progressive motion of the whirlwind would concur.

74. Nevertheless, agreeably to the observations which have lifted the whirlwind theory above the reach of my strictures, hurricanes in the West Indies begin (*at every place*) from a northern quarter, and changing first west, and afterwards to a southern quarter, terminate their fury. Thus, agreeably to the evidence of Mr. Redfield, the fury of the hurricane is the least where, according to his hypothesis, it should be the greatest.

75. Having cited and endeavored to shew the futility of the only explanation which can be found in Mr. Redfield's essays of the mode in which whirlwinds are induced, I will quote a passage from which it would seem that they are supposed capable of being self-induced. Whence it would follow, that while free from any external cause, his "*rotary movement, which is the sole cause of destructive winds and tempests,*" could spontaneously, excite itself and the adjoining elements into a destructive commotion. From this statement, it appears that the author was not aware that in making it he gave a blow to his favorite idea of opposing and unequal forces, arising from gravitation and terrestrial motion, being the cause of stormy atmospheric gyration.

76. "*We may observe, also, that whirlwinds and spouts appear to commence gradually and to acquire their full activity without the aid of any foreign causes; and it is well known they are most frequent in those calm regions where apparently there are no active currents to meet each other, and they are least frequent where currents are in full activity.*" (This Journal, Vol. XXXIII, p. 61.)

77. Treating of whirlwinds excited by fire, the author thus expresses himself: "*The foregoing results can only be explained by a violent vortical action steadily maintained.* * * * *The ascending power of the vortical column or whirlwind, is strongly exhibited.* * * * *But the spire of a columnar vortex exhibits a penetrating and ascending power which far exceeds, both in its intensity and the extent of its action, any other ascending movement that we witness. This effect appears to be owing to the spiral motion of the column which presses onward in the direction of its axis, till it reaches a limit of elevation yet unknown.*" (This Journal, Vol. xxxvi, p. 56.) Would it not be as reasonable to expect the spiral of iron usually employed to open bottles, spontaneously to penetrate a cork without being actuated by the operator's hand, as that the aerial spiral, which agreeably to the description above given, constitutes a tornado, should, "*without any foreign aid,*" "*or any currents to meet each other,*" be endowed with the force which he has described. Admitting the storm-producing efficacy of a collision between trade winds and islands, admitting that gravitation, and rotary and orbitual force are to be substituted for all other agency, how are those causes to extend influence to his aerial isolated spiral, so as to beget the wonderful vortical force portrayed?

78. I do not deem it expedient to enter upon any discussion as to the competency of the evidence by which the gyration of storms has been considered as proved. By Mr. Espy that has been ably contested. I have given some reasons for doubting the accuracy or consistency of Mr. Redfield's representations, though I have no doubt they have always been made in perfect good faith. I have already alleged, that were gyration sufficiently proved, I should consider it as an effect of a conflux to supply an upward current at the axis. Yet the survey of the New Brunswick tornado, made on *terra firma* with the aid of a compass, by an observer so skillful and unbiassed as Professor Bache, ought to outweigh maritime observations, made in many cases under circumstances of difficulty and danger. In like manner great credit should be given to the observations collected by Professor Loomis respecting a remarkable inland storm of December, 1836. This storm commenced blowing between south and east to the westward of the Mississippi, and travelled from west or northwest to east or southeast at a rate of between thirty and forty miles

per hour. There appears to have been within the sphere of its violence an area, throughout which the barometric column stood at a minimum, and towards which the wind blew *violently* on the one side only from between east and south, and on the other only between north and west. This area extended from southwest to northeast more than two thousand miles. Its great length in proportion to its breadth seems irreconcilable with its having formed the axis of a whirlwind. The course of this storm, as above stated, was at right angles to that attributed by Redfield to storms of this kind. (Trans. of the American Philos. Society, Vol. 7.)

79. Having said so much against the whirlwind theory of storms, it may be expected that I should, on this occasion, say something respecting the opinions which I entertain of their origin. To a certain extent this will be found in my communications published in this Journal, Vol. XXXII, p. 153, Vol. XL, p. 137, also in my essay on the gales of the United States. I still believe our northeastern gales were correctly represented in the last mentioned essay as arising from an exchange of position made between the air of the Gulf of Mexico and that of the territory of the United States which lies to the northeast of that great estuary; and that the heat given out during the conversion of aqueous vapor into rain, by imparting to the atmosphere as much caloric as could be yielded by twice its weight of red hot sand, is a great instrument in the production of the phenomena; also, that the cold resulting from rarefaction is a cause of the condensation of that vapor, and of course of clouds. On this last idea, derived from Dalton, Mr. Espy has founded his ingenious theory of storms; alleging, erroneously, as I think, the buoyancy, resulting from the heat thus evolved, to be the grand cause of rain, also of tornadoes, hurricanes, and other electrical storms. In the essay above mentioned, I erred in ascribing too much to variations of density arising from changes of elevation, and twenty years' additional experience as an experimenter in electricity, has taught me to ascribe vastly more to this agent than I did formerly. To pursue this subject fully, would give this paper an undue length; yet I will subjoin a series of suggestions which in September last were submitted to the Royal Academy of Sciences at Paris. These will serve to give a general idea of the views which I entertain of the electrical causes of storms.

80. Our experiments make us familiar with two processes of electric discharge. In one of these electricity passes in the form of sparks or flashes, in the other it may be conveyed, without any perceptible evolution of light, by the alternate or successive contact of intervening bodies with the excited surfaces: as for instance by means of pith balls, pendula, or a blast of air. The former process has lately been designated by Faraday as "*disruptive*," the latter as "*convective*" discharge.

81. The disruptive process being exemplified by lightning, the magnificent apparatus of nature, by means of which this awful phenomenon is displayed, may be supposed competent to produce convective discharge upon a scale of proportionable magnitude, as exhibited in tornadoes and hurricanes.

82. As bodies oppositely electrified attract each other, *à fortiori*, attraction must always exist between any bodies sufficiently electrified for an electric discharge to take place between them. This law may be illustrated by means of an instrument called Cullbertson's electrometer. Hence the rising of the water within the track of a tornado and its subsidence on the passage of lightning, as observed by Mr. Allen, near the city of Providence, R. I.,* may be considered as resulting from the alternation of convective with disruptive discharge. By this observation of Mr. Allen, attraction is shown to have existed between an electrified stratum of air coated by clouds, and the oppositely electrified water of a subjacent river. It is reasonable to infer that attraction, originating in the same way, operating upon the denser stratum of the atmosphere in the vicinity of the earth, by counteracting gravitation may cause that rarefaction by which houses are burst or unroofed, and an upward current of tremendous force produced. We

* "The most interesting appearance was exhibited when the tornado left the shore and struck the surface of the adjacent river. Being within a few yards of this spot I had an opportunity of accurately noting the effects produced on the surface of the water." The circle formed by the tornado on the foaming water, was about three hundred feet in diameter. Within this circle the water appeared to be in commotion, like that in a huge boiling cauldron; and misty vapors, resembling steam, rapidly arose from the surface, and entering the whirling vortex, at times veiled from sight the centre of the circle, and the lower extremity of the overhanging dark cone of vapor. Twice I noticed a gleam of lightning or of electric fluid to dart through the column of vapor which served as a conductor for it to ascend from the water to the cloud. After the flash the foam of the water seemed immediately to diminish for a moment, as if the discharge of the electric fluid had served to calm the excitement on its agitated surface.

may also infer that bodies are carried aloft by the joint action of the electrical attraction, and the vertical blast which it produces.

83. The effects upon the leaves of trees noticed by me after the tornado of New Brunswick in 1835, and still more those subsequently observed by Peltier after that of Chatenaye in 1839, cannot be explained without supposing them to have been the medium of an electric discharge.*

84. When a convective discharge takes place between a stratum of air in proximity to the earth and a stratum in the region of the clouds, the greater density and pressure of the lower stratum, will cause the discharge to take place in a vertical direction.

85. Any heat imparted to air in rising from the terrestrial surface to the region of the clouds, by the condensation of aqueous vapor, being applied to the upper part of the column and rendering it as much taller as lighter, cannot speedily make its total weight less than that of the surrounding air, and must therefore be insufficient to cause any violent change, like those which constitute tornadoes or hurricanes, as argued by Mr. Espy. Moreover the process on which so much stress has been laid by this ingenious meteorologist, cannot generate rain storms during which the rain freezing as it falls, the temperature of the lower stratum is shewn to be below the freezing point of water, while that of the upper stratum, within which water condenses in the liquid form, must be above that point.

86. Were the causes assigned by Espy adequate to create a tornado or hurricane, a storm of this kind would exist incessantly in the vicinity of the equator, where in consequence of the never ceasing ascent of warm moist air from the ocean, that afflux of this fluid from neighboring regions takes place, to which the trade winds are attributed.

87. Experience has demonstrated that electricity cannot exist on one side of an electric, without its existence simultaneously on the other side. If the interior of a hollow globular electric be neutral so will the outside be; but if the interior be either positively or negatively electrified, the outside will be found in the one case positive, in the other negative.

88. The atmosphere is an electric in a hollow globular form, and as electricity is known to pervade the space within it occupi-

† See this Journal, Vol. XXXVIII, p. 80.

ed by earth, the principle in question must also pervade the space beyond that portion of the atmosphere which is sufficiently dense to insulate, or to perform the part of an electric.

89. Thus there are three enormous concentric spaces, of which the intermediate one is occupied by an electric, while the innermost one and the outer one are occupied by conductors. The two last mentioned may be considered as equivalent to two oceans of electricity, of which one may be called the celestial, the other the terrestrial electric ocean. For an adequate cause of diversity in the states of the electric oceans, it must be sufficient to refer to the vaporization and condensation of water. The power of this process to electrify, has recently been confirmed by the electrical sparks caused by the escape of high steam.

90. When either electric ocean is minus the other must be plus, and at the same time any intermediate stratum of the atmosphere enclosing a stratum of clouds, must be charged by induction if not by communication. Between the concentric strata of air, severally bounding the celestial and terrestrial ocean, there must be an electrical attraction tending to counteract gravitation and thus to influence the density and pressure of the lower stratum of the atmosphere.

91. The proximity of a stratum of clouds electrified by the celestial ocean, must cause an accumulation of electricity in any portion of the terrestrial surface immediately subjacent; and by counteracting gravitation, cause a local diminution of atmospheric pressure which is, it is well known, a precursor and demonstrably a cause of wind and rain.

92. Those enormous discharges of electricity which take place during hurricanes, may be accounted for by supposing that they result from discharges between the celestial and terrestrial electric oceans. Thunder clouds may owe their charges not only to the vaporization and condensation of water, but also to the celestial ocean previously charged by that process. Auroras may be the consequence of discharges from one part of the atmosphere to another, through the rare conductive medium which is occupied by the celestial ocean: or they may result from discharges from other planets or suns, or from any part of space however remote. Since, agreeably to Wheatstone's experiments, electricity flies with a velocity not less than that of light, distance can create no obstacle to its passage.

93. In November last, subsequently to the submission of the opinions above expressed to the Academy, I verified a conjecture of my friend Dr. J. K. Mitchell, that moist, foggy or cloudy air is not a conductor of electricity, its influence, in paralyzing the efficacy of electrical apparatus, arising from moisture deposited on adjoining solid surfaces.

94. A red hot iron cylinder, upon which evidently, no moisture could be deposited, suspended from the excited conductor of an electrical machine, was found to yield sparks within a receiver replete with aqueous vapor, arising from a capsule of boiling water.

95. Hence it appears that bodies of air, whether cloudy or clear, may be oppositely electrified, from each other or from the earth. This would explain the gyration on a horizontal axis which seems to be attendant on thunder gusts, and may account for the ascent of the southeaster and descent of the northwester in the great storm of Dec. 1836, described by Prof. Loomis.

96. Such gyration may be a form of convective discharge, in which electrical reaction is assisted by calorific circulation and the evolution of latent heat, agreeably to Dalton and Espy.

97. Squalls may be the consequence of electrical reaction between the terrestrial surface and oppositely excited masses of air, and the intermixture of masses so excited, in obedience to the same cause, may be among the sources of rain, hail, and gusts. The specific gravity of a body of air, electrified differently from the surrounding medium, may be lessened by what is called electric repulsion; the particles inevitably moving a greater distance from each other, as similarly electrified pith balls are known to do.

98. Hence a cause of rarefaction, buoyancy, and consequent upward motion, in a column of electrified air, more competent than that suggested by Espy.

99. Should it be verified that a gyration from right to left takes place, during convective discharges of electricity in hurricanes, it may be referrible to the disposition which a positive electrical discharge from the earth to the sky would have to gyrate in that direction.

ART. XII.—*Notice of two New Fossil Mammals from Brunswick Canal, Georgia; with observations on some of the fossil quadrupeds of the United States;* by R. HARLAN, M. D.

UNDER the head MEGATHERIDÆ, in the Penny Cyclopædia, Vol. 15, there is an exceedingly interesting description of the fossil animals included under this family, by Professor Owen of London. This distinguished naturalist admits five genera, viz. Megatherium, Megalonyx, Glossotherium, Mylodon and Scelidotherium; to which might be now added the "Orycterotherium" recently described by me in the Transactions of the American Philosophical Society. In this paper Mr. O. has constructed a new genus under the name of "Mylodon," from my description of the *Megalonyx laqueatus*, (vid. Med. and Phys. Researches,) together with an inferior jaw of another species obtained by Dr. Darwin, in South America; the former he names *Mylodon Harlani*, the latter *Mylodon Darwinii.* We have no objections to the construction of a new genus of the *M. laqueatus*, although we think there are scarcely sufficient data for the change under our existing knowledge of the remains of this extinct animal;—as no new light has been added to its structure since the description of the animal in the Medical and Physical Researches, 1835; from which we extract the following remarks:—"It possesses peculiarities of organic structure which certainly entitle it to the rank of a distinct species; indeed a minute examination of the tooth and knee-joint, render it not improbable, that if the whole frame should hereafter be discovered, it may even claim a *generic* distinction; in which case, either *Aulaxodon* or *Pleurodon* would not be an inappropriate term; referring to the ribbed or fluted form of the mesial aspect of the tooth." p. 330.

Mr. Owen has also made this extract from my paper, when making the new genus, and without adopting my generic name, which is very applicable,—changes the name altogether to *Mylodon Harlani.* The Greek μύλαι, *dentes molares*, conveys no distinctive character whatever as applied to this animal; the English of *Mylodon* is "molar teeth, tooth," and is equally applicable to any fossil mammal with which we are acquainted. *Pleurodon*, on the contrary, would apply to this and to all of the species described under the name of *Megalonyx Jeffersonii, M.*

laqueatus, *Mylodon Darwinii*, and to which might be now also added *Orycterotherium Missouriensis.* In fine, *Pleurodon* would characterize a group of genera, but *Mylodon* affords no character whatever.

Prof. Owen has recently read a memoir before the Geological Society of London, on the fossil bones contained in Mr. Kock's collection now exhibiting in London, and during last autumn in Philadelphia. Mr. O. after a minute examination of the numerous portions of the mastodons in this collection, of every age and size and of both sexes, many with the tusks of the inferior jaw in various stages of development; and on the existence of which the late Dr. Godman attempted to construct a new genus under the name of "*Tetracaulodon*"—arrives at the conclusion, that all these mastodon crania belong to one species, and that the genus "Tetracaulodon" is without foundation. A conclusion at which we arrived immediately, so soon as the name was published; our opinion was made public at the time, and again republished in the Medical and Physical Researches, p. 257. Copies of this notice were sent to scientific persons abroad, to editors of journals, &c., and Mr. Owen possessed a copy. The notice was also republished in Jameson's Edinburgh Journal. The genus "*Tetracaulodon*," has long since been consigned to the "tomb of the Capulets." The subject, in fine, is one upon which no two naturalists could contend in opinion. If a difference of opinion had existed, the decision of Prof. Owen, with such a mass of material on which to found his judgment, with the naturalists of Europe, will admit of no appeal.

In the Transactions of the American Philosophical Society for 1831, I published a notice of "Ichthyosaurian Remains discovered in the State of Missouri." This essay was republished in the "Medical and Physical Researches," 1835, p. 344. Subsequently in 1839, January 9th, I read a memoir upon the same subject before the London Geological Society, and proposed to change the name of this animal to "*Batrachosaurus Missouriensis.*"

I was shown by Professor Goldfuss of the University of Bonn, in Oct. 1839, a principal portion of the skeleton of a fossil animal of this kind, brought from Missouri by Maximilian Prince de Wied.

With these preliminary observations I proceed to offer a brief description of a fossil Sus and a fossil Chelonia, recently obtained from Georgia. I am indebted to my intelligent friend and collaborator, J. Hamilton Couper, Esq. of Georgia, for two boxes of fossil bones, collected with much care and labor, during the excavations made in the construction of the Brunswick Canal, Georgia. The bones were principally obtained from a post-pliocene formation—the Cetacea and Chelonia were probably from the greensand. The collection consists of the remains of the following genera, viz. Megatherium, beautifully preserved specimens of the teeth and lower jaw; Mastodon, Elephant, Hippopotamus, Bos, Sus, Chelonia, and Whale. These valuable specimens are destined by the liberal donor for the cabinet of the Academy of Natural Sciences of Philadelphia. The cases also contained specimens of soil and fossil shells, mostly of recent species.

Specimens of fossil Sus have rarely been discovered; the few detached relics of this nature are derived from turfs and superficial soils. Baron Cuvier remarks, "I have never known these remains accompanying elephants." Indications of the existence of a fossil Sus I discovered several years since, in a collection of fossils obtained by Mr. Nuttall, in Newbern, North Carolina, in the newest tertiary, post-pliocene,—these were the teeth of a Sus, occurring along with mastodon, elephant, elk, deer, horse, seal, cetacea, tortoise, shark, skate, snake and fish,—all congregated together as if in the mouth of some great antediluvian estuary, and commingled with fossil shells, many of which are of existing species.

I have recently examined and taken casts of the tooth of the *Mastodon longirostris*, found in the miocene of Maryland; hitherto found only on the continent of Europe, in equivalent strata.

Sus *Americana.**

The remnant consists of the left ramus of the lower jaw, completely petrified, and impregnated with iron; containing three molar teeth, a portion of a fourth, and a socket for the anterior molar, making five on each side of each jaw, besides large tusks and incisors in the perfect jaws. The jaw has been fractured anteriorly behind the tusks, and posteriorly, immediately at the origin of the coronoid process; the foramen for the nerves and vessels through the body of the bone is very large. The following are the dimensions of the fragment of jaw.

Total length of the fragment, - - - -	$9\frac{1}{4}$	inches.
" height of do. at alveoles and base, - -	$3\frac{3}{8}$	"
" breadth of same, - - - - - -	$1\frac{5}{8}$	"
Length of last molar, - - - - - - -	$1\frac{7}{8}$	"
Breadth of do. - - - - - - - -	$0\frac{7}{8}$	"
Length of alveolar processes, - - - -	6	"

The drawing (Plate III, Fig. 1) representing the exterior or dermal aspect, reduced size, obviates the necessity of more minute detail.

The crowns of the molars are so worn by detrition as to have destroyed their specific characters—the animal appears to have died at a very advanced age. In size, the animal probably surpassed the largest of our common hogs. In form of the jaw, general appearance, and number of the teeth, this fragment bears a close analogy with the same part in the *Sus babirussa*, Buff., or *babyroussa*,—which species of hog does not exist in the American continent. The structure and composition of the molars are similar, but the Babyroussa was a much smaller animal. Vide Plate III, Fig. 1.

CHELONIA *Couperi.**

The right *os femoris* of a Chelonian or marine tortoise, pretty well preserved, and well characterized as a nondescript species, came to my hands, along with the others, but without a number or label attached, as in most of the others. It is completely petrified, heavy, and impregnated with iron. It bears comparison with figures 33 and 34, plate 12, of a recent Chelonia, Cuvier, Ossem. Foss., edit. 1824; and with figures 11 and 19, plate 15, for a fossil specimen. In one remarkable respect, this thigh bone differs from the same part of all recent or fossil specimens, viz. on the exterior and anterior aspect of the shaft, precisely where in other species the bone is smallest, it is here enlarged by a strongly marked scabrous protuberance or exostosis, for the attachments of powerful muscles, *vide* Plate III, Fig. 2, (*a*): so that if this species was not larger than those at present existing, it was probably proportionally stronger. The trochanter has been broken off. Total length, 13 inches. Circumference at the middle of the shaft, 9 inches. A portion of the shield of a Chelonian occurred along with this bone.

Philadelphia, May 15, 1842.

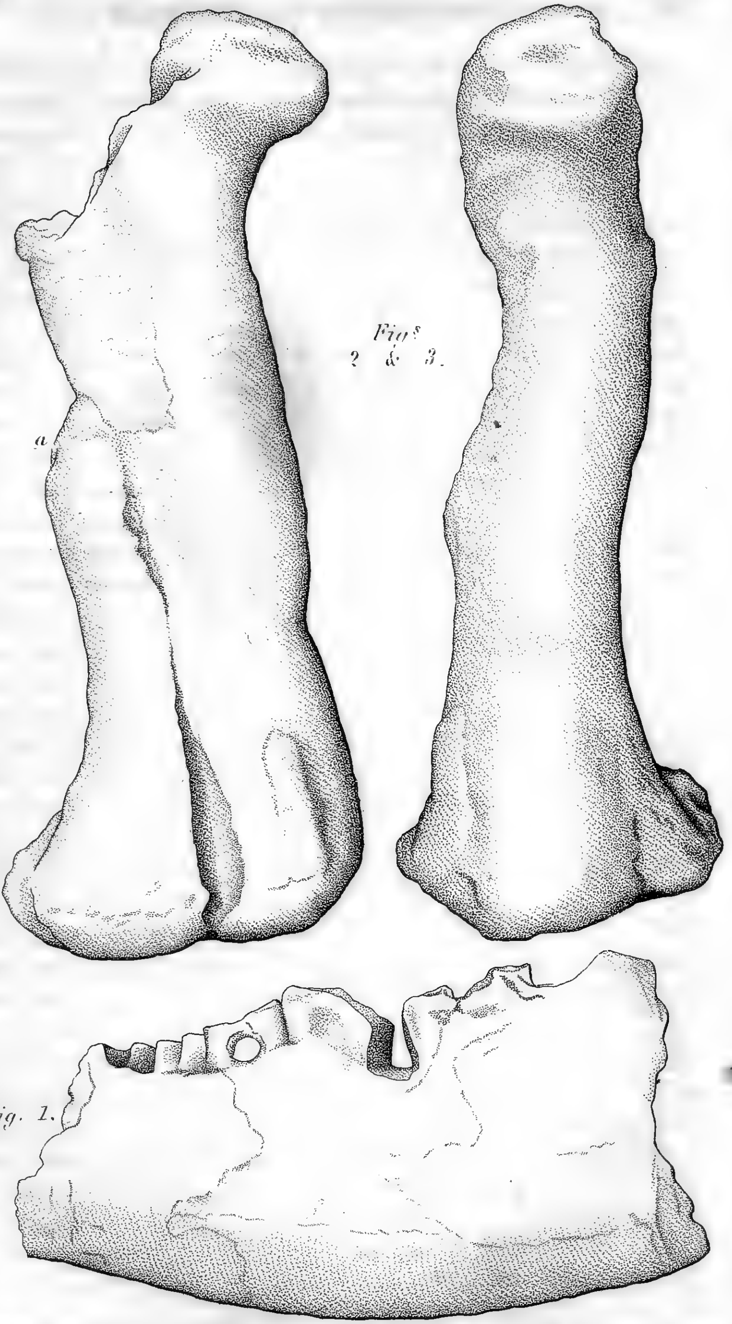


Fig. 1. Sus Americana (*Harlan*) *fragment of the left ramus of lower jaw, dormal aspect.*
Figs 2 & 3 Chelonia Couperi (*Harlan*) *right os femoris.* *a. scabrous protuberance.*

ART. XIII.—*Description of a New Species of Thracia;* by C. B. ADAMS, Prof. Chem. and Nat. Hist. Middlebury College.

THRACIA INEQUALIS.

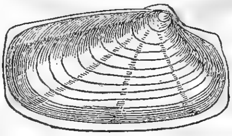
T. testâ fragili, per-inequilaterali, per-inequivalvi, irregulariter striatâ, posticè truncatâ; valvâ sinistrâ subplanulatâ; alterâ perconvexâ; callo nymphali cochleariformi, anterius elongato; ossiculo lunato, semicirculari.

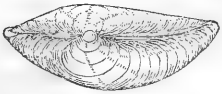
Shell white, very thin, before broadly and behind narrowly truncate, very inequilateral and inequivalve, much deflected to the left anteriorly; with the striæ of growth unequal, numerous and crowded at the extremities, where, under a magnifier, the surface appears shagreened by minute wrinkles of the striæ; *epidermis* very thin, brownish, thicker at the extremities; *left valve* nearly flat, with five obtuse angles radiating from the beak; *right valve* much larger and very convex, emarginate in the whole of the posterior truncation, with a groove and elevated umbonial angle defining the areolar region, its inferior margin sinuous; *beaks* small, pointed, lamelliform, the right one moderately excavated for the reception of the other; *nymphæal callosities* spoon-shaped, very much produced forwards and inwards; *ossiculum* semicircular and lunate, with an impression on the centre of each side, but much deeper on one side, situated between the spoon-shaped apophyses and the dorsal margin.

Dimensions.—Length 1.2 inch.; height .75 inch; width .45 inch; length of ossiculum .1 inch.*

Cabinet of Middlebury College.

Habitat, Gulf of Mexico.





Remarks.—A single specimen of this interesting species was presented to the cabinet of this college by the Rev. Wm. T. Hamilton, of Mobile, Ala. It is remarkable for the disparity of the valves, the irregularity of its form, and the sharp lamelliform beaks.

* The ossiculum is enlarged about 2½ linear diameters.

Art. XIV.—*Third Annual Meeting of the Association of American Geologists and Naturalists.**

Monday, April 25th, 1842, 9 o'clock, A. M.—Association met at Boston, pursuant to adjournment of last meeting.

Dr. Morton (the chairman) not having arrived, *Prof. Locke* was called to the chair. *Dr. C. T. Jackson*, secretary. *Mr. Josiah D. Whitney* and *Mr. Moses B. Williams* were appointed assistant secretaries.

Letters were then read by the secretary from *Messrs. W. W. Mather, Robert Gilmore, H. H. Hayden, Baron Lederer, Francis Markoe, Jr., R. Harlan.* An extract from a letter received from *Dr. Douglas Houghton*, was read by *Prof. Beck.* It was then

Resolved, That all those gentlemen, whether of this or any other country, who are interested in geology and the allied branches of science, and who may be present on this occasion, be invited to unite with the Association in its deliberations.

A letter being read by the secretary from *Prof. Silliman*, stating his readiness to comply with the wishes of the Association, either to deliver his address before the Association alone or before the public:—It was

Resolved, That the address of Prof. Silliman be delivered to the Association in presence of the public.

Resolved, That the local committee be authorized to make all necessary arrangements for the accommodation of the audience during the delivery of this address.

Resolved, That any gentleman requesting permission to read a paper, on condition that it be returned to him without an abstract of its contents having been entered on the minutes, may have the privilege, on merely allowing its title to be recorded.

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* As a rule of the Association excludes mere oral remarks from the records on account of the difficulty of reporting them correctly, but sanctions the subsequent communication of them by their authors, and as these minutes were thus furnished by some gentlemen and not by others, this will account for the very disproportionate space occupied by the remarks of different individuals, as published in the annexed abstract of the proceedings. Many valuable observations have thus been lost which there is much occasion to regret, and particularly those of Mr. Lyell, of which no minutes were communicated, although the Association listened to him with much satisfaction during the several periods when he favored them with his views.

Provided only, that in all cases where the paper is to be withdrawn, as above, there shall be no discussion on the subject.

The Association then adjourned until 3½ o'clock, P. M.

Monday, April 25th, 3½ o'clock, P.M.—*Prof. Locke* in the chair.

Prof. Locke exhibited sections of the rocks of the lead regions of the Upper Mississippi, with remarks on the geology of the west.

Prof. L. proceeded to state as follows:—I present to-day some geological sections of the lead region of the Upper Mississippi. These were made by myself during the survey of the Mineral Lands ordered by Congress, and by Dr. Owen and myself with numerous assistants in 1839. A detailed report of that survey was made to the Department of the Land Office early in 1840, but owing to some mismanagement at Washington, it was published without the illustrations, which were numerous, and so connected with the text that the document became nearly unintelligible without them. As this paper, imperfect as it is, has been seen by few of our geologists, and as the sections before us are chiefly in connection with what I have denominated the cliff limestone of the west, I will ask leave to read from my printed report some remarks upon that rock. This I do more especially as it appears not to be known or recollected that I have a claim to the discovery that the metalliferous rock of the Mississippi is identical with the cliff limestone of Ohio, and that the same rock wherever it has been found is more or less metalliferous. [Here was read part of the report of Prof. L. to Dr. Owen, referred to as published in Document 239, 26th Congress, United States.—The following sections were also exhibited and explained.]

"I. A section from the heights of Little Mahoqueta through Dubuque Mines to Sinsinawa Mound, fifteen miles. This section exhibited,

1. The cliff limestone, containing in its middle and lower portions the lead veins.
2. The blue limestone (Trenton limestone).
3. Presumptively, the lower magnesian underlying the blue.

"II. A section at Prairie du Chien exhibiting the following rocks, descending series:

1.	Soil and cliff limestone,	60 feet.
2.	Blue fossiliferous limestone,	115 "
3.	Buff colored limestone,	20 "
4.	Soft saccharoid sandstone,	40 "
5.	A portion covered by soil,	40 "
6.	Lower magnesian limestone resembling the cliff lithologically, but is nearly destitute of fossils,	190 "
7.	Saccharoid sandstone,	30 "
	This last is exposed only at low water.	——
	Total,	495 feet.

"III. A section from Blue Mounds to Wiskonsin River, exhibiting the following descending series of rocks:

1.	Beds of siliceous chert, containing the fossils of the cliff and forming the peaks of the mounds, - -	410 feet.
2.	The cliff limestone, containing in its lower portion lead ore, - - - - - - - - -	169 "
3.	The blue fossiliferous limestone, very thin, and in some places wanting, - - - - - - - -	00 "
4.	Saccharoid sandstone, - - - - - - -	40 "
5.	Alternations of saccharoid sandstone and lower magnesian limestone, - - - - - - - -	188 "
6.	Sandstone, - - - - - - - - -	3 "
7.	Lower magnesian, - - - - - - -	190 "
	Total, - - - - - - - - - -	1000 feet.

By lower magnesian limestone is not meant the magnesian limestone of Europe. The name was given by Dr. Owen in contradistinction to the cliff limestone, (which is the upper magnesian,) both containing magnesia. What has been denominated by me the cliff limestone,—a name adopted by Dr. Owen,—is properly divided into three portions, which other geologists may consider three distinct formations.

The following is Dr. Owen's subdivision of the cliff series: p. 24, Document 239, 26th Congress.

"*Upper beds.*—More regularly stratified, and less frequently vertically fissured than the middle and lower. Also, more rich in siliceous fossils, containing layers of chert, and indeed passing wholly into masses of flinty rocks, containing also good iron ore, and much crystallized carbonate of lime; but lead rarely, and in unprofitable quantities.

"*Middle beds.*—Aspect more arenaceous, though it contains but a small per centage of sand. Cherty masses are rare. Stratification imperfect, with numerous vertical fissures. Rich in ores of lead and zinc, associated with iron in small quantities.

"*Lower beds.*—Also of arenaceous appearance; rather more distinctly stratified than the middle beds, and imbedding more frequently than these siliceous cherty masses. They contain the same ores as the middle beds, with the addition of copper ore and sulphuret of zinc."

These several beds are distinguished by their fossils. The several fossils enumerated by Dr. Owen are:

"*Upper beds.*—*Terebratulæ*, several species of *Catenapora*, *Calamipora*, *Columnaria tubipora*, *Aulopora*, *Sarcissula*, *Astrea*, *Cyathophylla*, *Caryophylla* and *Orthocerites*.

"*Middle and lower beds.*—*Coscinipora* (*sulcata*? Gr.), the only coralline, a *Cirrus* resembling *perspectious; Ampularia*, in perfect impressions of a long, spiral univalve, resembling the genus *Vivipara*. It seems by the above, that there was no absolute zoological distinction between the middle and lower beds."

Permit me here to add as a claim of the western geologists, rather strangely overlooked by some *eastern* writers on *western* geology,—that besides these all the other western rocks yet made known, have been described by western geologists. Especially the bed of mountain or carboniferous limestone, superimposed on the cliff at the upper rapids of Mississippi, underlying the great Illinois coal basin, cropping out at St. Louis, and forming the bluffs at and above Alton, Illinois, with its characteristic fossil, the *Archimedes* of Le Seuer, was well known to Messrs. Troost, Owen and myself. The same rock occurs within the limits of the survey of the Professors Rogers, who belong, in part at least, to the western corps. In 1839, I had the pleasure of comparing notes with Prof. James Rogers, on the characters of this very rock as it occurs in Indiana and Illinois on the one part, and in Western Virginia on the other. I hope yet more specifically to settle the claims of the various *laborers* in our western geology. At the same time I would observe that it is impossible for an eastern geologist, without visiting the west, or even by a post-haste journey over the trans-Appalachian world, to write upon its geology without committing errors injurious to his own reputation, the publication of which, he would of course, gladly recall.

Remarks were offered and facts stated on the above subject by *Dr. King*, *Mr. Haldeman*, *Mr. Teschemacher*, *Prof. Henry D. Rogers*, *Dr. C. T. Jackson*, *Prof. Vanuxem*, *Prof. Hitchcock*, *Prof. Beck*, and *Dr. Dana.*

Mr. Haldeman laid on the table, at the request of Dr. Morton, some copies of a work on cretaceous fossils, bringing our knowledge of this subject near the present day, most of these being from the researches of Prof. Nicollet.

A letter was read from *Prof. Park* of Philadelphia, regretting his inability to attend the present meeting. The Association adjourned to—

Tuesday, April 26th, 9 o'clock, A. M.—*Prof. Locke* in the chair. The committee on the constitution and by-laws was called upon for report. *Dr. Jackson* read the rules, as submitted by this committee.

*Constitution and By-Laws of the Association of American Geologists and Naturalists.**

Art. I. The Society shall be called "The Association of American Geologists and Naturalists."

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* The constitution and by-laws as here printed, were in fact adopted at the session of Wednesday, but it is thought expedient to insert them here, as they embrace all the rules which were adopted on Tuesday and thus to avoid repetition.

Art. II. The objects of this Association are the advancement of geology and the collateral branches of natural science, and the promotion of intercourse between those who cultivate them.

Art. III. All those persons whose names have already been enrolled in the published proceedings of the Association, and those who have been invited to attend the meetings, shall be considered members on signing the Constitution and By-Laws.

Art. IV. Members of societies having in view the same objects as this Association and publishing transactions, shall be considered members upon subscribing to the Constitution and By-Laws.

Art. V. Persons not embraced in the above provisions may become members of the Association, upon nomination by the standing committee, and by concurrence of two thirds of the members present.

Art. VI. The officers of the Association shall be a chairman, a secretary, and a treasurer, who shall be elected at each annual meeting.

Art. VII. The secretary may appoint two assistant secretaries to aid him in the discharge of his duties.

Art. VIII. The Association shall meet annually for one week—the time and place of each meeting being determined by a vote of the Association at the previous meeting, and the arrangements for it shall be entrusted to the officers and the local committee.

Art. IX. The standing committee shall consist of the chairman, secretary, and treasurer, with nine other members present who have attended the previous meetings.

Art. X. It shall be the duty of the standing committee to nominate members for admission, and to manage the affairs of the Association.

Art. XI. The local committee shall be appointed by the standing committee from among members residing at or near the place of meeting, and it shall be the duty of said committee to make arrangements for the meeting.

Art. XII. The expenses of each meeting shall be defrayed by an equal assessment on the members present.

Art. XIII. All communications to the Association shall be presented in writing, and upon them discussions may take place which shall not be reported, but the facts presented in such discussions may be reduced to writing by the persons communicating them, and they may then be handed in at a subsequent session, when they may be entered on the records.

Art. XIV. If communications are made, and notice is given that they are to be withdrawn for publication elsewhere, they may be read, but no discussion shall take place on them.

Art. XV. No article of this Constitution shall be altered or amended without the concurrence of three fourths of the members present, nor

unless notice of the proposed amendment or alteration shall have been given at the preceding annual meeting.

Dr. Morton having arrived, took the chair as president of the meeting.

Resolved, That *Prof. Locke, Dr. Jackson*, and *Prof. Hitchcock*, be appointed a committee to prepare business for the Association.

Prof. Hitchcock then read a paper "on the Phenomena of Drift in this country," which was illustrated by numerous drawings, and a map of the United States, on which were drawn lines representing the course of the striæ, and lines of dispersion of bowlders. In the course of his paper Prof. H. called on *Mr. Gray* to describe a remarkable moraine in Andover, Mass. Mr. Gray stated this moraine to be one mile long and fifteen or twenty feet in height. At the close of this paper, an animated and extended discussion arose on the subject of drift.

Dr. Jackson objected to the views of Prof. Hitchcock, as published in a recent report on the Geology of Massachusetts, but having had an opportunity, since those views were published, of conversing freely with Prof. H. he found but little real difference in their present opinions. He would, however, by no means consider that we could yet form an unobjectionable theory on the subject of drift, polished grooves, and the transportation of erratic blocks of stone. If we admit several different causes, how remarkable would it be should they be found to have acted in nearly the same direction! Yet we cannot agree upon any known cause, as sufficient to explain all the facts. This country exhibits no proofs of the glacial theory as taught by Agassiz, but on the contrary the general bearing of the facts is against that theory; for we observe nowhere in this country a general radiation of detritus from the principal mountain ranges, although, as in Rhode Island, there is a divergence from the point whence the bowlders were derived. This divergence is however merely a spreading of fifteen miles for forty in extent, and it is in the usual general direction of North American drift to the southward; none of the bowlders having been drifted to the north of their parent bed.

Mr. Lyell offered some remarks on the subject of the distribution of bowlders and of the furrows in the rocks, citing the result of many observations in Europe.

Mr. Redfield had from his limited observations been led to infer that the drift of the region near New York was the joint result of glacial and aqueous action, and was mainly deposited during a period of increasing submergence. Mr. Redfield also alluded to the agreement of the striæ of the polished rocks, and of the transported bowlders and drift, with the known course of the existing polar currents of the ocean, in the northern hemisphere; and suggested that this system of currents, being essentially the same in both hemispheres and having its cause in the dynamics of the solar system, must have operated through all time, and over extensive regions, but varying in locality and direction with the changes of outline and relative levels of seas and continents, during successive geological periods.

Some discussion then ensued on the question whether the mounds of the western United States were the result of natural diluvial causes or the work of the Indians.

Mr. Lyell cited an instance where the inhabitants of Scandinavia, had taken advantage of a long and very high natural ridge, to form three separate mounds, which they afterwards considered as the burial places of their fabulous deities.

Prof. Silliman remarked with respect to the genuineness of mounds, as works of man, in contradistinction from those natural piles, that have been cut out of the strata of clay, sand, gravel, loam, &c., and rounded and shaped by water so as to resemble works of art—that artificial mounds (found in many and distant countries, both on the eastern and western continent) appear to have been characteristic of a particular state of society advanced beyond barbarism, but not yet sufficiently civilized for the construction of massy sepulchres of solid stone, sarcophagi, pyramids and temples. He appealed to those numerous mounds which form a most impressive feature of the scenery on Salisbury plain in Wiltshire, in the southwest of England. Prof. S. had counted seventy of these mounds in one view, while sitting upon his horse upon the top of a low one, and from the same place Dr. Stukeley says that he enumerated one hundred and twenty eight. These mounds are rarely less than thirty feet in diameter; they are generally surrounded by a broad ditch, enclosed by a circular or oblong parapet or embankment. Near Overton in the west of England, Prof. S. ascended one which was one hundred and seventy feet high and whose base covered about an acre of ground, its form being that of the lower segment of a cone.

The void, from which the earth was taken, remains to this day, and is as evidently an artificial excavation, to form an artificial hill, as any modern fortification with its ditch and glacis. There remains not the smallest doubt, that these mounds were erected both as sepulchres, for distinguished individuals, and as monuments of victories. The remains of the dead have been often found in them, either skeletons or ashes—with heads of spears, swords, bones of horses, dogs and other domestic animals, sometimes beads, trinkets, and female ornaments, articles dear to the departed while living and which were believed to be important to them in another world.

Prof. H. D. Rogers remarked in relation to Mr. Lyell's opinion of the gradual rising of the North American terraces, that if such was the case, fossil shells or marine sedimentary accumulations, should be found at all elevations on the mountain slopes, which are covered with marks of diluvial action, at every height. It has not been shown by examination that such is the case, hence he infers that the cause which produced the elevation was paroxysmal in its operation and effects, and not secular, or gradual, and uninterrupted. In order to explain the theory of diluvial phenomena, he would suppose with Mr. Lyell, and others, that the region around the north pole was capped with ice, in immense masses, and that by a sudden outburst of volcanic action, this was dispersed, and sent in a quaquaversal direction towards the equator. But if we suppose that this was accompanied by an earthquake, rocking, or wave-like motion, of the bed of the ocean, the whole mass of torn-up strata would be shoved violently from N. to S., and at every heaving of the earth, a mass of water would be thrown forward, like the rolling in of a tremendous surf. Mr. Couthouy's observations among the coral islands, would go to strengthen this theory, while the rocking movement of the earth's surface during an earthquake, had been long ago admitted.

Mr. Couthouy remarked in relation to the paroxysmal rise of the land at intervals, that on one island which he had visited, which was about two hundred feet in elevation; about one half way from the base to the summit, the face of the cliff was deeply sea-worn and indented; as its present base would appear should it be at this moment raised above the ocean level, when it would present similar marks of powerful and long continued action of water, at the part which was before on a line with the sea. In

regard to the bowl-shaped cavities, encircled on all sides by regular hills, he suggested that they might have been worn by the rotary motion of icebergs; this rotary, or semi-rotary motion of the icebergs, he had noticed both in those which were and were not stranded. They become gradually worn away on one side by the action of the water, when they turn over with a displacement of the sea, and violent upheaving of the mud and sand, rendering the water turbid to a great distance.

The discussion was continued by *Mr. Lyell* and *Mr. Couthouy*, on the probable agency of icebergs in diluvial phenomena, and especially in regard to the water-worn cavities or pot holes.

Dr. C. T. Jackson described the pot holes which occur in Orange, near Canaan, in the elevated land between the Connecticut and Merrimack rivers in N. Hampshire. They are worn in a hard granite-gneiss, in a line following the general N. and S. direction of the diluvial or drift current. One which had been cleared of the round smooth stones which formerly filled it, and which is known to the inhabitants as "the well," is eleven feet deep, four and a quarter feet wide at the top, and two feet at the bottom. These pot holes could not be referred to the action of any existing current of water, as they are on the water-shed line, between the two rivers, and more than one thousand feet above the sea level.

Mr. John H. Blake was requested to prepare a paper on the tertiary and drift of the Andes.

Prof. H. D. Rogers remarked in relation to stranded icebergs, that coming from the north, loaded with bowlders, and stranded far above the sea level, they would, while melting, produce all the phenomena of the glaciers of the Alps.

Mr. Couthouy was requested to draw up a paper, embracing the facts which he had collected in regard to icebergs, to lay before the Association. Mr. C. having, in accordance with this request, prepared the following summary of his observations and the remarks he had made concerning them, at the present session, it is here inserted.

Mr. C. premised that in order to give the remarks he was about to submit, their full weight, it might be proper for him to state, that he had no preconceived opinion—no hypothesis of his own upon this question, to sustain. His intention was simply to offer a few facts which had fallen under his personal observation, with the inferences to which they

had led his own mind, leaving abler judges to decide upon the value of such facts and the correctness of the inferences. He remarked that the opportunity of witnessing the actual operation of the huge bodies of drifting ice, known as Bergs or Islands, was of so rare occurrence that its true character appeared to him not clearly understood, and consequently geologists were liable to overlook or err in judgement upon some important points in the dynamics of aqueo-glacial agency. Mr. C. then proceeded to a statement of the geographical position of a number of icebergs, as determined by reference to his journals. The first noted was observed on the 28th of May, 1822, during a passage from Havana to Rotterdam, and was in 42° 10′ N. lat., 44° 50′ West from Greenwich. Its size must have been very considerable, as it was visible from the deck of a vessel of two hundred tons, for eighteen miles. Numerous small streams of water were pouring down its sides, and a boat was sent with a view to obtain a supply, but on approaching it, the swell, notwithstanding its being quite calm, was found to dash against its face with such force, and the lower portions were so worn and ragged, as to render it inaccessible. Although the weather was so serene, and the sea so tranquil, yet the berg was constantly turning slowly round as the swell struck its many promontoriform projections. It appeared to have lost little of its primal magnitude, the summits retaining a conical or rounded form, instead of being worn like others he had seen, into sharp pinnacles and acicular ridges by the action of the atmosphere and rain.

The next observed by Mr. C., was on the return passage in September of the same year. It was aground on the eastern edge of the great Bank of Newfoundland, in 43° 18′ N. lat., 48° 30′ W. long. Sounding three miles inside of it, the depth was found to be one hundred and five fathoms, and as the water deepens rapidly toward the edge of the bank, the berg must have been in at least one hundred and twenty or one hundred and thirty fathoms. There was a heavy sea running at the time, causing it to rock, and oscillate horizontally to and fro, with a heavy grinding noise distinctly audible to all on board. A fresh wind from the east was continually forcing it farther up on the bank, but in the event of a contrary gale springing up, it would doubtless have been driven off again into deep water to pursue its course to a milder clime, loaded with materials ground into its base while stranded.

Between this period and the summer of 1827, several icebergs were seen by Mr. C., but not being able at present to lay hand on his journals of that interval, he could enter into no particulars, farther than to state that as with a few exceptions, his voyages were between the United States or West Indies and Great Britain or the Mediterranean, it was probable that they were chiefly met between the 36th and 42d parallels of north

latitude. He remembered however, having encountered in November, 1825, off the entrance to the Rio de la Plata, in latitude 35° south, longitude 49° west, or thereabouts, a number of icebergs, some of which were of large magnitude ; a reference to the chart would, he observed, show to what a vast distance from their birth-place these floating masses had been driven by wind and current.

In the month of August, 1827, while crossing the Grand Banks, in latitude 46° 30′ north, longitude 48° west, Mr. C. passed within less than a mile of a large berg which was stranded in between eighty and ninety fathoms water. The wind was light, but a heavy swell was running from the westward, and the huge pile could be distinctly seen to rock and shake violently as it ground heavily down into its bed with every surge. Owing to its longest diameter facing the swell, the mass had an oscillatory or semi-rotary back and forward motion upon its vertical axis, according as the sea broke upon one or the other extremity, which it did with so much force at times as to turn the berg apparently full half round; in this situation it would remain till another heavy surge striking the opposite end would force it back and round in the other direction. The vessel was sufficiently near for Mr. C. to perceive distinctly, large fragments of rock and quantities of earthy matter imbedded in the sides of the iceberg, and to see from the fore yard, that the water for at least a quarter of a mile round it, was full of mud, stirred up from the bottom by the violent rolling and crushing of the mass. This movement was accompanied by a harsh grating noise, with occasional cracking reports, resembling those produced by blasting rocks, which might have been heard ten or twelve miles. The height of this berg was estimated by Mr. C., at from fifty to seventy feet, and its length at four hundred yards. While examining it through the glass, it was observed to incline suddenly more than usual, and in the next moment, with a crash and roar that were truly fearful, and amid a whirlwind of spray and foam, the whole enormous pile rolled over on its side, tearing up with it, no doubt, large quantities of matter from the bottom, and loading the sea with mud and sand for more than a mile in all directions from its bed. On the 27th of April, 1829, Mr. C. passed, in latitude 36° 10′ north, longitude 39° west, near the middle of the Gulf Stream, which there set in an east-south-easterly direction, an iceberg estimated to be a quarter of a mile long, and from eighty to one hundred feet high. It was much wasted in its upper portion, which was worn and broken into the most fanciful shapes, forming resemblances of minarets, spires, pyramids and castellated ridges, whose character was momentarily changing by reason of the berg moving backward and forward horizontally with great quickness. A strong breeze, and numerous smaller fragments of ice floating in its vicinity, prevented a very near approach,

but on one side, a large earthy colored patch was seen, having numerous blacker spots, which Mr. C. had no doubt were bowlders, scattered over it. Some of these presented a surface of two or three hundred square feet.

In 1831, on a passage from Boston to Mobile, at daylight of 17th August, in latitude 36° 20′ north, longitude 67° 45′ west, upon the southern edge of the Gulf Stream, Mr. C. fell in with several small bergs in such proximity to each other, as to leave little doubt of their being fragments of a large one, which weakened by the high temperature of the surrounding water, had fallen asunder during a strong gale which for several days previous had prevailed from the southeast. The natural tendency of this would be to force the berg into the warm northeast current of the stream, where, already much worn by its prior sojourn there while crossing from the north, its separation soon took place. The strong northwest wind immediately following the southeast gale, probably drove the fragments out of the Gulf again, to where they were seen in the eddy current, which Mr. C. found to set in that place southwest, at the rate of half a mile per hour. And here, said he, a suggestion of much geological interest presented itself to his mind. Supposing an iceberg of the present day to break loose from the northern polar regions, loaded with blocks of stone and gravel, and drifting southward, to strand upon the Banks of Newfoundland, or George's bank near our own shores, and there remain for a considerable period grinding themselves upon the ocean's bed, thereby incorporating into their mass, portions of it, such as shells, gravel, sand, clay or stones. Owing to the unequal action of the weather upon its surface, and water on its submerged portion, it might as has been shown, turn partially or even entirely over, thus placing the newly gathered matter above water, and if the old were at the bottom previously to the overturn, mixing together the rocks from both localities. Loaded with this additional material, it might float off and resume its southerly course, till accidentally forced into the Gulf Stream and carried eastward at the rate of 24′ a day, (the mean velocity of the Stream in the meridian referred to,) till it was melted away. To affect this dissolution would require three or four months, during which time, the berg would be carried six or seven hundred miles in a direction nearly at right angles with its primary drift, depositing a greater or less quantity of transported material along its entire track. Mr. Couthouy remarked that the instance just cited, was one of peculiar interest, from its illustrating the manner in which rocky materials imbedded in icebergs, may through the devious course of these latter, be deposited along a wide range of longitude as well as latitude. He called attention to the fact that this berg was to the southward of the Gulf Stream, and about 18° or seven hundred and fifty miles west of a

meridional line, passing through the centre of the grand Bank of Newfoundland. It was the only case within his knowledge, of an iceberg being seen so near our continent in this parallel. He shewed by reference to a chart of the Atlantic, that in all probability this one entered the Gulf Stream at least as far eastward as the 48th deg. of west longitude, and in the 42d or 43d parallel of north latitude. It was his opinion that this occurred in the spring of the year, when the prevalent strong northeast winds would drive it southerly across the stream with nearly as much rapidity as the latter would carry it forward in an easterly direction. To exemplify this, said Mr. C., we should work out the drift, and true course of this berg, precisely as a seaman would do that of a ship hove to the wind for the same length of time, and under like circumstances. Assuming then that the berg in question, had impinged upon the Gulf Stream in the latitude and longitude above given, and there encountered one of the northeast gales, so frequent, and of such long continuance on our coast in the spring;—half a mile per hour would be a moderate allowance for its set southwestward by the wind and heave of the sea. In forty days, (and it is well known that easterly gales often prevail over this part of the Atlantic during the spring months, for even a longer period;) in forty days, it would, were there no opposing agency at work, be propelled three hundred and forty miles west, and the same distance south of its point of entrance into the Gulf Stream. But as in this parallel, there is a current setting in an east by south direction, with a mean velocity of three quarters of a mile per hour, this would during the assumed period, not only counteract the wasting caused by the swell, but carry the berg three hundred and sixty-eight miles east, and one hundred and twenty miles farther south, making its true line of drift up to the close of the forty days, to be south 38° east, and the distance traversed four hundred and seventy miles. This would place it in latitude 34° 50′ north, longitude 38° 30′ west, or about across the Stream, here not far from four hundred and fifty miles wide. From this point to the locality in which the fragments were seen, its course would be about south 84° west, and the distance one thousand four hundred and seventy miles. Assuming that the eddy current and heave of the sea combined, were equal to impelling it westward at the rate of three quarters of a mile an hour, it would require about eighty days to transport it to the locality in question. But as the wind although acting upon it generally from the eastward, cannot be supposed to have done so constantly, it might be a considerably longer time in performing the voyage.

Mr. Couthouy exhibited a chart of the Atlantic, with the assumed track of the iceberg met by him, marked upon it, and pointed out that its drift westward must have been at least as great as he had there repre-

sented; since it could not, owing to the trend of the coast of Newfoundland, have entered the Gulf to the westward of the point designated, but on the contrary was likely to have done so farther eastward. Moreover, as it could by no possibility have reached the spot where he fell in with it, without having been driven across the Gulf Stream into the westerly eddy, it was obvious that unless the heave southwestward by the northeasterly wind and swell were admitted, it must have been for a much longer period in the Stream and finally emerged to the southward of it, at a point much farther south and east than he had assumed in his calculation of its course.

That a mass of ice so considerable should remain after so long a sojourn amid the warm waters of the Stream, would not, he observed, appear surprising, when the enormous magnitude of some of the masses that have been encountered by voyagers in these seas was taken into account; together with the fact that they produce by their dissolution, carry about with them, and occasion to a great distance around them, a very material decrease of temperature, both in the air and ocean, which tended to render the operation a much more gradual one than we might at the first glance imagine. From the record of a journal kept by Francis D. Mason, Esq., in June, 1810, on a passage from New York to Halifax, N. S., and published in Blunt's American Coast Pilot, edit. 1827, it appears that the water at seven miles from some icebergs, was from 12° to 15° below the average temperature where it was not affected by the presence of such bodies. One of these islands is represented as having been one hundred and fifty feet in height, and a mile in extent. It was easy to conceive of masses like this, resisting the action of air and water for a much longer period than would suffice to place the berg, whose course has just been described, so far from the point of its northern entrance into the Gulf Stream.

The last iceberg of which Mr. C. was prepared to speak from personal observation, was encountered by him on the 4th of March, 1841, in the Pacific Ocean, during a passage from the Hawaiian islands to Boston. It was of great magnitude. Its height could not have been less than two hundred and eighty or three hundred feet, and its longest diameter two thirds of a mile. The ship sailing at the rate of seven miles an hour, was two hours and three quarters in coming up with it after it was first seen from the deck, when it already loomed up like a large islet. Immediately on its discovery the ship was headed directly for it, till within half a mile of the berg, at which distance it was passed. Without the aid of a glass Mr. C. distinctly saw enormous masses of rock projecting from different parts of this ice mountain, some of them apparently having a surface of at least twenty feet square. The swell, which was very heavy from the westward, washed

up the sloping sides to the height of eighty or one hundred feet, recoiling in vast sheets resembling cataracts; and where the face of the berg was perpendicular, the surf broke against it as if it had been a wall of rock, with tremendous force, and a booming roar like that of distant heavy thunder. There appeared to have been a recent overturn of the berg, inasmuch as the water for a mile's distance from it was full of fragments, some of them sufficiently large to endanger a vessel. One of the most remarkable phenomena observed by Mr. C., was the almost incredibly rapid revolution of this huge body on its vertical axis, in consequence of which, it did not present the same aspect for two minutes together. One moment it was a pyramid, the next barn-shaped, and in another a glittering pile of peaks and serrated crests, or battlements, like those of some ancient castellated citadel, was exhibited. Scarcely was there time to sketch the rudest outline of one configuration, ere it gave place to another totally dissimilar. This melting away of the various figures, could be compared to nothing better than the sudden and fanciful changes we see in turning a kaleidoscope. Mr. Couthouy here exhibited to the Association a series of sketches taken at the time as illustrative of the variety of form spoken of. The following statement of the temperature of the air and ocean at various distances from the berg, was given as evidence of the great extent to which they were affected by its presence, and the influence which, as before mentioned, this circumstance exerted on the retardation of the dissolution of similar masses:

	Noon.	2 P.M.		3 P.M.	3 30 P.M.	4 P.M.	4 30 P.M.	5 P.M.	5 30 P.M.
Air,	54°	53°		50°	46°	42°	37°	35°	37°
Water,	50°	50°		48°	44°	43°	36°	36°	40°
Distance of berg,	33′	19′	(visible,)	12′	8′	4½′	1′	3′	6′

When nearest the iceberg, (which was within a short half mile,) the water was at a little below 34° Fahr., and the air at 35°. After passing the island, when about two miles to leeward, a smart fall of hail was experienced, which lasted about ten minutes. By this statement it appears, that the water three miles to leeward of the island was 7° Fahr. colder than that four and a half miles to windward, and at six miles, 3° colder than at four and a half and 4° colder than at eight miles to windward, owing probably to a surface current carrying the cold water from it in the direction the wind was blowing. The latitude of this ice island was 53° 20′ S., and its longitude 104° 50′ W., making its distance from Terra del Fuégo, the nearest eastern land, one thousand four hundred and fifty miles, and one thousand from St. Peter's and Alexander's Islands, the proximate southern land from which it could have been detached. From its great magnitude, it was the opinion of Mr. C. that should this berg have been driven by the westerly

gales which prevail in that region of the Pacific during so large a portion of the year, into the current setting constantly to the northward along the whole west coast of South America, it might have floated to the verge of the tropics ere it dissolved entirely, or perhaps been stranded somewhere about the shores of the Chiloan Archipelago.

The attention of the Association was called to the fact of such large masses of rock, which were undoubtedly once at the bottom of the berg, being exposed on its face or sides. Mr. Couthouy conceived that the dissolution below the surface by the action of the water, and above it by that of the weather, being unequal in different portions of the berg, especially when it was aground, and consequently one side more constantly exposed to the sun's rays than the other; the equilibrium would be occasionally destroyed, the result of which would be an overturn, like that witnessed upon the Grand Banks, bringing to the surface portions of the mass containing rocks and earth. The U. S. ship Peacock, during her last cruise of discovery in the Antarctic Ocean, while attempting to penetrate the great barrier of ice, was seriously injured, and narrowly escaped utter destruction, from the separation and toppling down of a huge fragment of an iceberg. Had not this latter been still attached to the main body, there can be no question but that one of the violent overturns referred to, would have followed such a change in the proportions of the berg. Again, in the case of a drifting island, where from its rotary motion it is probable the waste from exposure would be nearly equal on all sides, it is evident that the side in which the rocks were imbedded, would, owing to their specific gravity being much greater than that of the ice, gradually preponderate, and either produce a sudden and violent change of axis, or slowly settle down once more, according as circumstances varied. In smooth, still water, the latter would probably occur, while the former might be expected to happen in a tempest or a heavy sea. In connection with these facts, Mr. C. submitted the following supposititious case, as one by no means of improbable actual occurrence, the first portion of which, indeed, was merely a statement of what had really taken place in the great iceberg last described. Suppose an island of ice to be detached from the great southern barrier, having its base loaded with rocks, &c., and after drifting several hundred miles northward, to experience an overturn bringing these rocks to the surface. It then floats on for a considerable distance farther, till from the equilibrium being again destroyed, the rocky portion settles down and resumes its original position. These alternations may occur several times. Driven landward by the heavy westerly swell into the continental northern current, it is at length stranded on the coast of South America, and undergoes one or more overturns, bringing up at each time an additional amount of

material. It then is forced off by a strong off-shore wind, and after drifting still farther north is stranded again, perhaps at a long distance from its first anchorage. New overturns follow, fresh materials are accumulated, but from waste, the whole mass becoming lighter, it is once more floated off, and pursuing a somewhat devious course toward the tropics, is gradually melted away. Could that part of the ocean's bed over which such an iceberg has passed be laid bare for our inspection, what would be the appearances presented? The early progress of the mass would be marked by a deposition of large angular fragments of polar rocks. Subsequent to the overturn there would be an interval with few or no traces of its path, till the rocky portion of the berg had resumed its original situation, when the deposition would be continued, and these alternations would evidently correspond to the number of overturns. The larger masses of rock would for the most part be the first to drop out, and latterly the majority of matter might consist of smaller and more rounded fragments, such as had been worn by the grinding of the ice on the beach or bottom. Prior to the last, or even the first stranding, all, or nearly all the rock and earth originally contained in it might be deposited, when the latter portion of its track would be marked by a comparatively scanty amount of material from its more recent halting places, perhaps confusedly mixed, and affording here and there some slight indications of the birth-place of the berg, in the occasional presence of a fragment of the remote Antarctic soil.

Was there aught, asked Mr. C., in the evidences of ancient aqueo-glacial action, analogous to such a mixed deposition, and irregular distribution of materials from widely separated localities, as would result from the conjectural case here presented, or the actual one of the iceberg previously cited as fallen in with on the southern margin of the Gulf Stream? Did they explain any of the obstacles and apparent anomalies presented by the aqueo-glacial theory of the drift formation? These were questions which he submitted for the decision of those whose attention had been more specially directed to this subject.

In reference to the advance and northern limits of icebergs from the Antarctic in the eastern hemisphere, Mr. C. could state nothing from his personal knowledge, farther than that they frequently occur at least as low as the thirty-fifth parallel of latitude. During his residence in New South Wales, in the summer and autumn of 1839–40, (December to March,) several ships arriving at Sydney from England, reported having fallen in with large icebergs in the vicinity of the Cape of Good Hope, at least 1800 miles from the nearest southern land; along the whole of which distance they possibly deposited material from their polar starting point.

Mr. C. stated that he would here offer a few brief remarks upon the bearing of the facts he had submitted upon the question of the results of aqueo-glacial action in past times, and especially in the effects produced upon subjacent rocks by the stranding of icebergs. It was with much diffidence that he dissented from the opinion entertained by some eminent geologists, that this circumstance had any agency in producing the parallel grooves constituting so remarkable a feature in the rocks of New England. Even assuming that in a former era the drifting masses of ice had pursued an uniformly direct course from north to south, though this might explain the general distribution of erratic blocks and bowlders, yet it appeared to him highly improbable that their grounding, and then being driven forward by the combined forces of wind and sea, could ever have produced the furrows in question. There is no reason why the oscillatory or semi-gyratory movement, should not then have followed such an accident as it does now, in which case, as at present, the tendency would be rather to obliterate all such marks, (had they previously existed,) and form a deep hollow if passing over a yielding surface, or a confused scratching and grinding down of a rocky one. It had been shown, however, that the icebergs of the present day pursue a very irregular course, and although their general progress is truly from north to south, or the reverse, yet impelled by varying winds and currents, they deviate widely both east and west of a meridional line. Did not this fact in some measure explain the difference pointed out by Prof. Hitchcock as apparently existing between the line of direction observable in the distribution of bowlders, and that of the diluvial scratches? It had been suggested, that at the period when the drift was deposited there was no Gulf Stream to affect the course of floating ice, but while this may be very true, it does not follow that there were no currents whatever. It struck him that to assume the production of our parallel grooves by the action of stranded ice, was to presuppose a state of things, a combination of circumstances amounting to a physical impossibility.

Not only must it be taken for granted that there were no currents, or at least but one from the pole to the equator, and only one perennial wind blowing in the same direction, but the floating masses must either have been of such nicely balanced proportions, and melted with such uniform regularity, and the waves must have struck them so exactly from the same quarter, as to have prevented any change of position; or they must have been in such numbers and so closely packed as to preclude any oscillatory movement.

Was it essential to the explanation of the phenomena of drift, to assume that the distribution of bowlders, and the production of our so-called diluvial scratches, were entirely the result of contemporaneous

action? Might there not have been a period when the northern portion of our hemisphere was covered with glaciers resembling those of the Alps, during which the furrows were produced by their gradual and radiolinear advance, followed by one of drifting ice, (whether borne along with a sudden rush of waters, caused by a paroxysmal elevation of land in the vicinity of the pole, or floods resulting from a gradual melting away of the mass, he would not now pause to inquire,) depositing bowlders through its course, and by the stranding and grinding of large masses into beds of sedimentary matter or drift, have occasioned the singular contortions visible in portions of the clay strata?

If it could be shown that a sudden and violent rush of waters from the polar region had taken place, sweeping over the whole northern portion of this hemisphere, bearing along with it large islands of ice, denuding the hills and filling the valleys with drift, and eventually subsiding almost as rapidly as it poured southward,—would not this induce a belief that the remarkable, large bowl-shaped cavities described in Prof. Hitchcock's able memoir on the drift of New England, as existing on Cape Cod and elsewhere, might have been formed by the stranding and grinding of large islands of ice down into the recently deposited drift? It occurred to Mr. C. at once, when these excavations were alluded to by Prof. Hitchcock, in connection with ice, that they might have originated in this manner, rather than from the deposition of matter round the melting ice, as suggested by that gentleman,—or they may have been produced by a combination of these two operations; the grinding and settling down of the stranded berg, excavating a hollow, while the earthy materials contained in it would be piled up round the sides as it dissolved. If we supposed a very large berg of the pinnacled character, to have been left aground by the subsidence of the paroxysmal flood, and divided into several smaller ones, each forming a separate crateriform bed for itself, we should then readily comprehend the production of such a group of these cavities as was described by Prof. H. Whether these suggestions were borne out by the geological features of the drift in general, was left for those to determine whose observation had been more specially directed to a study of these phenomena. Mr. Couthouy observed that he would merely repeat that in relation to the production of diluvial, or to speak more correctly, glacial furrows, he had no preconceived views of his own to support, but that when he first heard them attributed to the grating along the bottom of icebergs, he was convinced by the recollection of what he had personally witnessed of the action of ice under such circumstances at the present day, that this never would have produced such results. The parallelism and uniform direction of the striæ, appeared to him conclusive of a different agency in their formation. He felt persuaded

that no person who had once seen the actual movements of a stranded iceberg, would ever afterwards entertain for a moment the idea that such a cause would produce the furrows under consideration. He also thought it very problematical whether icebergs would by their stranding, and being irregularly pushed forward by wind and wave, produce moraines, having much if any affinity with those resulting from the slow, regular advance of the Alpine glaciers.

He offered these suggestions with no small hesitation, fully sensible how presumptuous it might seem in him to venture a difference in opinion with those eminently distinguished geologists who had addressed the Association on this topic. They were, however, such as arose naturally in his mind while reflecting on what had passed under his own observation. The facts on which they rested were before the members, and so little was really known, so few had an opportunity of witnessing this part of the aqueo-glacial agency now going forward, he felt sure that they would excuse his having trespassed on so much of their time in submitting at least these facts for their consideration.

In conclusion, Mr. Couthouy remarked, that he had in this paper used the term *aqueo-glacial* to express the nature of the action of water and ice, in connection with the deposition of drift, rather than that of *glacio-aqueous*, proposed by Prof. Hitchcock in his memoir, not merely for its greater euphony, but because he thought it more expressive of the relations of the transporting media, of which water rather than ice was the predominant, or at least the active agent, and therefore entitled to precedence in a descriptive phrase like this.

A communication was then read from *Dr. Hale,* inviting the Association to make use of the library and rooms of the American Academy. The Association adjourned to

Tuesday, 3½ o'clock, P. M.—*Prof. Wm. B. Rogers* was called to the chair in consequence of the indisposition of the president.

Dr. Jackson exhibited a drawing of the pot holes described by him in the morning, and gave a farther description of the same, and the discussion of the morning was carried on by *Prof. Henry D. Rogers, Prof. Emmons, Prof. Hitchcock, Mr. Redfield,* and the chair.

Prof. Beck read a paper "on certain pseudomorphous or parasitic minerals in the State of New York," on which remarks were offered by *B. Silliman, Jr., Dr. Jackson,* and *Prof. Emmons.*

Mr. Vanuxem read a paper "on the Origin generally of Mineral Springs," which he followed by some remarks on the metal-

liferous ores found by himself in the State of New York, together with some observations in regard to the fissures in rocks.

Association adjourned to Wednesday, 9 o'clock, A. M.

In the evening *Prof. Silliman* delivered a most interesting address on the "Progress of Geological Science in this country," to the Association, in presence of the public, who had been invited to attend.

Wednesday, April 27th, 9 o'clock, A. M.—Association met pursuant to adjournment, *Dr. Morton* in the chair. A letter was read by the secretary from *Mr. Richard C. Taylor.*

The constitution, as reported by the committee on the constitution and by-laws, was then read by the secretary. Articles I, III, and IV, were carried with amendments; the other articles were carried as reported.*

Resolved, That an additional article be prepared by the committee, providing for the future alteration or amendment of the constitution and by-laws.

Resolved, That Prof. Silliman be requested to publish his address before this Association in the American Journal of Science as one of its articles.†

After some remarks on the subject of drift, *Prof. Emmons* offered the following resolution on the subject of drift, which was carried.

Resolved, That the subject of drift in our country receive still farther examination from the committee, and that a farther report be made at the next meeting of the Association. Objections to the views presented and as it has been treated by geologists in general are, that many phenomena are confounded together: as, 1st, the washing up of ridges along the shores of lakes; 2d, those of glaciers; 3d, of icebergs; 4th, alluvial beds; 5th, the accumulation of bowlders along what were ancient coasts; and 6th and 7th, pot holes and slickensides. Icebergs do not necessarily act upon rocks when borne along, inasmuch as they are supposed to be defended by soft materials, as gravel, sand, and mud; and that they explain merely the *distribution of bowlders,* and their peculiar movements when grounded are not likely to form parallel grooves or scratches. The theory of an hemisphere of ice

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* The Constitution will be found under Tuesday's proceedings.

† This address will form the leading article in our next number.—Eds.

capping the whole at least of the northern region is objectionable from the utter extinction of life, especially of molluscous animals, which does not appear to have been the case, as there is an uninterrupted or unbroken series from the eocene to the present.

Resolved, That a committee of three or more be appointed, each to make a distinct report on the subject of drift.

Prof. Emmons, *Prof. Wm. B. Rogers*, *Mr. Vanuxem*, *Mr. Nicollet*, and *Dr. Jackson*, were appointed on the above committee.

Resolved, That all committees which have not reported this year, be instructed to report at the next meeting.

Resolved, That a committee of one be appointed to inquire through all available sources in regard to the influence of icebergs on drift. *Mr. Couthouy* was appointed on the above committee.

Prof. Locke read a paper on the ancient earthworks of Ohio. A discussion followed some remarks of the chairman (Dr. Morton) on this subject, between *Prof. Locke*, *Mr. Nicollet*, *Dr. King*, *Mr. Haldeman*, *Prof. Silliman*, *Prof. Hitchcock*, and *Prof. Bailey*. Mr. Nicollet related several observations relative to the manners and customs of the Indians, made during a long residence in their country, having a bearing on the construction and age of these mounds.

Resolved, That a committee be appointed to examine and report on the subject of western mounds. The following gentlemen were appointed on this committee.

Prof. Locke, *Mr. Nicollet*, *Mr. John H. Blake*, *Dr. Engelman*, *Mr. S. P. Hildreth*, *Prof. Troost*, and *Dr. B. B. Brown*.

Adjourned to Thursday at 9, A. M., the afternoon being appropriated to the delivery of an address before the Boston Society of Natural History, by the chairman of this Association.

Thursday, *April 28th*, 9 o'clock, A. M.—The Association met according to adjournment, *Prof. Silliman* in the chair. Proceedings of the former meetings were read and accepted.

Resolved, That *Mr. John L. Hayes* be added to the committee on the subject of icebergs, and that he be requested to prepare a separate report.

The committee appointed reported an article relative to amendments of the constitution, which was adopted as a part of the constitution.

Resolved, That on Friday at 9, A. M. the Association proceed to the choice of officers for the next annual meeting, and also to fix upon a place for the same.

Prof. Locke read a paper describing a new instrument invented by himself, and which he called a *Reflecting Level and Goniometer;* he described a reflecting compass of his invention, and read a paper "on a Prostrate Forest under the Diluvium of Ohio."

Prof. Hall made some remarks on the wood found underneath the drift in Washington.

Prof. Hubbard offered some remarks on the drift of New Hampshire, exhibiting a remarkable specimen of a bowlder of smoky quartz containing acicular crystals of rutile.

Resolved, That Prof. Hubbard be added to the committee on drift.

Dr. C. T. Jackson read a paper "on the Tin Veins of New Hampshire," exhibiting specimens of the ore both crystallized and compact, and an ingot weighing three ounces of the reduced metal obtained from five ounces of the ore, the accompanying minerals of the vein at Jackson, also specimens of the yellow blende of Eaton and the black blende of Shelburne, with a specimen of the reduced metal from each, and a specimen of the associated lead ore.

Prof. W. B. Rogers adverted to the occurrence of oxide of tin in Virginia, associated with the auriferous quartz and other minerals of some of the gold mines. As yet he had discovered it at only a few localities. It is in the form of very small crystals scattered at wide intervals, and even where it occurs is perhaps the rarest of all the metallic minerals found in and contiguous to the gold veins. In the two or three instances in which it was found in place, it was imbedded in a talco-micaceous slate, near its junction with the auriferous quartz. The minerals met with in the talcose and micaceous slates, which usually include the veins and beds of auriferous quartz, are auriferous, common, arsenical and cupreous sulphurets of iron, sulphuret of copper, carbonate of copper, sulphuret of zinc, sulphuret of lead, sulphur in minute crystals lining the cavities of cellular quartz, metallic gold, peroxide of iron, phosphate of lead beautifully crystalline, oxide of tin and oxide of bismuth, both exceeding rare.

In connection with Dr. C. T. Jackson's remarks on the occurrence of sulphuret and other ores of zinc in New Hampshire,

Prof. W. B. Rogers mentioned that he had found the sulphuret of zinc sometimes, and the silicate (electric calamine) generally and very abundantly in the lead mines of Wythe Co., Virginia. The *latter mineral* often occupies a great part of the breadth of the vein, lying for the most part beneath the lead ore, sometimes as a sub-crystalline mass and sometimes in groups of small radiating crystals. The *sulphuret* is chiefly met in nests and thin veins, in the sparry and magnesian limestone adjoining the lead ore, and is intermixed with crystals and small seams of galena.

Prof. Rogers added, as a fact of mineralogical interest, that besides the *sulphuret of lead,* these mines yield in some instances quite a large proportion of *carbonate,* of which beautifully pure crystalline specimens are by no means uncommon; and what is still more interesting, they furnish a very considerable amount of *red oxide* or *native minium,* with a small proportion of *yellow oxide,* both of which have hitherto been regarded as very rare minerals. From its resemblance to ferruginous earth or clay, this red oxide was until lately regarded at the mines as worthless, but is now highly valued for its productiveness in metal.

Dr. C. T. Jackson exhibited a specimen of meteoric iron from Claiborne County, Alabama, in which he discovered chlorine in the form of chloride of iron and nickel, in 1834. (See this Journal, Vol. xxxiv, p. 332.)

Prof. J. B. Rogers referred to some analyses of meteoric iron and meteorites recently made by him. A specimen of meteoric iron taken from a mass of many pounds weight in Grayson Co. Virginia, was found to contain 6.15 per cent. of nickel, and gave a very slight trace of chlorine. A meteoric stone from Georgia, made up of shot-like grains of nickeliferous iron with slender flattened threads of the same mineral imbedded in a paste composed chiefly of silicate of magnesia and alumina, gave no indications of chlorine. The grains yielded 7 per cent. of nickel.

Prof. W. B. Rogers stated that he had examined a mass of meteoric iron from Roanoke County, Virginia, and was unable to detect in it the slightest trace of chlorine. A fragment of meteoric stone from Ashe County, North Carolina, examined at the same time, was found to contain a marked quantity of this principle, the presence of which, however, was accounted for by the fragment having been in contact with a bag of salt, as it was carried home by the person who found it.

Prof. Hitchcock read a paper "on a new species of Ornithichnite from the valley of the Connecticut river, and on the rain-drop impressions from the same locality."

After Prof. Hitchcock's observations respecting the bird tracks of the Connecticut valley, *Mr. Lyell* alluded to the subject of the cause of the present dip of the formation, expressing the opinion that it is due, in part at least, to an uplifting of the strata.

Prof. H. D. Rogers mentioned the reasons which had induced him to attribute the dip of the beds in the other great tract of this new red sandstone, or that which ranges southwestward from the Hudson, to oblique deposition. A uniform northerly dip of about fifteen degrees prevails entirely across the basin, even where it is twelve or twenty miles in breadth, and coëxists with a manifest shallowness of the deposit. This want of vertical depth is seen in several places in Pennsylvania, where denudation has exposed, in the interior of the tract, large patches of the older Appalachian strata, upon which this new red formation rests unconformably. No traces of dislocation occur to lead to the inference that the shallowness of the basin is deceptive, and that the present want of depth in the deposit has been caused by a succession of up-throws with denudation. The steady northerly dip is very rarely influenced, either in amount or in direction, by any of the numerous dykes of trap which penetrate the formation.

Prof. Rogers next mentioned facts which go to shew that the formation of the Connecticut valley and the equivalent one of the Middle States, are in all probability, accumulations in two originally distinct estuaries. He mentioned as one evidence, the independent direction of the dip in the two basins, and stated that the absence of a parallel order of succession in the members of the two formations, tends likewise to strengthen this opinion.

Mr. Lyell conceived the steepness of the dip, which sometimes amounts to twenty degrees, but more especially its direction,—transverse to the course of the ancient estuary, to present a difficulty. Prof. R. endeavored however to shew that the present dip might have been the original one, by suggesting, first, that there is evidence in the nature of the materials of the great southern basin for believing that they entered the estuary *laterally* on the outcrop side, by streams flowing from a country of decomposing, talcose, chloritic and hornblende rocks; secondly, that if the channel was near the same shore, the velocity of the

tide might have prevented any horizontal deposition far out from the margin; and thirdly, that a gentle and steady *rising* of the region would, in conjunction with the proximity of the channel, tend to maintain both the slope of the sediment and the lateral advance of the shore which the hypothesis requires.

Mr. Benjamin Silliman, Jr., referring to the formation of the Connecticut valley only, considered a part of the present inclination of the beds to be the result of upheaval, connected with the outbursting of the trap.

Prof. W. B. Rogers made some remarks corroborating the views of Prof. H. D. Rogers in their application to the middle secondary or new red sandstone strata of Virginia and North Carolina. He described this group of rocks, consisting of shales, slates, sandstones and conglomerates of various tints of red and gray, as extending with some considerable interruptions in a nearly S. S. W. direction, entirely across the State of Virginia, and for some distance into North Carolina. With but a few local exceptions he had found the dip throughout this belt to be N. W. or N. N. W. Though destitute of the wide and prolonged ridges of trap met with in the corresponding districts of Pennsylvania and New Jersey, this region includes a great number of small dykes and knobs of trappean rock, penetrating the sedimentary strata, but in no instance causing any well marked change of dip in the adjacent beds. The materials of these strata Prof. R. stated to be very clearly traceable to the region of gneissoid and schistose rocks lying to the southeast of the tract, and in some cases, as in the limestone pebbles included in the conglomerate, could even be referred to the individual beds from which they had been torn.

He supported the opinion maintained for some years past by Prof. H. D. Rogers, that the inclination of the strata is not due to a tilting action subsequent to their deposition, but is the simple consequence of the influx of detrital matter from the southeast, and its deposition in a series of northwest-dipping planes. As greatly favoring this view he mentioned the fact generally observed in this belt throughout Virginia, that the strata become steeper in their inclination as we proceed towards the northwest; whereas the reverse should have been expected from a force tilting them from a horizontal or gently inclined position into the present northwestern dips. This opinion he conceived, was still

further confirmed by the appearance of the strata in some parts of the district, where in consequence of the removal of the sedimentary rocks from a narrow space entirely across the tract, he was able to trace the beds from their outcrop nearly to the bottom of the trough in which they were deposited. In this case, he found the inclination of the beds to continue unchanged downwards, instead of becoming more gently inclined towards the bottom, as might be expected on the hypothesis of an originally horizontal position with a subsequent uptilting movement.

Mr. Redfield spoke of fossil rain-marks of a very perfect character which he had observed with Mr. Lyell, at the quarries of new red sandstone near Newark, N. J. He also gave notice of the discovery of a new species of fossil footmark in the new red sandstone of Connecticut. The specimen which he had seen was found in the well known quarries at Portland, (formerly Chatham,) by Mr. Russell, one of the proprietors, and is now in the possession of Dr. Barratt of Middletown. These footmarks are wholly unlike the Ornithichnites described by Prof. Hitchcock, some of which have been found in the same quarries; but they have some little resemblance to the *Cheirotherium minus*, which is figured in the Bulletin of the Geological Society of France.

Mr. Redfield also exhibited a new species of fossil fish from Sunderland, Mass., which seems referrible to the genus *Palæoniscus;* and also called the attention of the Association to a difference of structure in the *Palæonisci* of the Sunderland locality from those of Connecticut in the same formation; while the latter have a perfect resemblance to the fossil fishes of New Jersey. He had also discovered an apparent error in his own printed notice of American fossil fishes, in having named Sunderland as one of the localities of the genus *Catopterus*, as further examinations had led him to doubt on this point; although this genus is more common than *Palæoniscus* in the new red formation, both in Connecticut and New Jersey.

Mr. Lyell and *Mr. B. Silliman, Jr.* offered some remarks on Mr. Redfield's observations.

Mr. John S. Hayes, in explanation of the fossil footmarks in the sandstone of Connecticut river valley, gave some account of the existing species of birds most nearly resembling those supposed to have made those tracks.

As going to show the inclined position of the strata at the time when these impressions were made, *Prof. W. B. Rogers* called attention to a peculiarity in the form of many of these impressions, noticed by himself and Prof. H. D. Rogers in company with Prof. Hitchcock, during the last summer, and often remarked by Prof. Hitchcock on previous occasions. The feature referred to resembles the effect of a slight sliding of the foot in soft clay. It is seen in some of the larger footsteps, both those which point upwards and downwards in reference to the present slope of the rocks, and is even more conspicuous where the animal has been walking horizontally along the inclined surface, in which case there is a protuberance on the downhill side of each impression, as if in virtue of the slope the pressure of the foot had accumulated the soft clay in that direction. Adjourned to

Thursday, 3½ o'clock, P. M.—*Prof. W. B. Rogers* in the chair. A communication from *Prof. Chester Dewey* on the polished rocks of Rochester, N. Y.

Dr. Locke exhibited about eighty colored casts of the fossils found in the western rocks, with explanatory remarks, and upon the advantages to be derived to geological science from the distribution of similar copies.

Mr. James Hall and *Prof. H. D. Rogers* offered some remarks on observations made in connection with Dr. Locke on the same subject.

Dr. King expressed the opinion that the fossils exhibited by Dr. Locke, were not generally the same as those common to the lead-bearing series of the upper Mississippi, and that from his investigations, which had been pretty extensive, he believed that the portion of the formation of that region in which the lead is found, overlies, and is very distinct from what is considered by Dr. Locke to be the *cliff* formation of Ohio. To this *Prof. Locke* replied that the fossils presented by him, were not presented as the fossils of that part of the cliff limestone, containing the lead ore; some of them were actually from the stratum overlying that ore.

Resolved, That the attention of the meeting be strictly confined to the reading of papers, during the remainder of the present session, and that no discussion be allowed thereon.

Mr. James Hall read a paper in connection with a section which he exhibited, of the rocks extending from Cleveland, Ohio, southwesterly to the Mississippi.

Prof. Locke offered some remarks, explanatory of Mr. Hall's opinion on the equivalency of the western formations.

Prof. Hitchcock read a paper on the determination of the silicified trunk of a tree found in the new red sandstone of Connecticut.

The Association then proceeded to the election of a standing committee.

Resolved, That this committee consist of the following gentlemen: *Prof. Edward Hitchcock, Dr. Ducatel, Dr. C. T. Jackson, Prof. Lewis C. Beck, Mr. Lardner Vanuxem, Dr. J. B. Rogers, Prof. J. W. Bailey, Prof. John Locke,* and *Prof. B. Silliman.*

Resolved, That *Dr. King* and *Dr. David Dale Owen,* be added to the committee on the western mounds. Adjourned to

Friday, April 29, 9 o'clock, A. M.—Association met pursuant to adjournment, *Prof. Beck* in the chair; minutes of the last meeting read; proceeded to the choice of officers for the ensuing year, according to the resolve of yesterday. The following gentlemen were unanimously elected: *Prof. Henry D. Rogers,* Chairman; *Prof. John Locke,* Treasurer; *Prof. Oliver P. Hubbard,* Secretary.

Resolved, That the next meeting of this Association be held in Albany, N. Y.

The secretary was requested to answer the communication from the National Institute at Washington, inviting the Association to meet in that city.

In consequence of the election of *Prof. Locke* to the office of treasurer, a vacancy was left in the standing committee, he being *ex-officio* a member of that committee. *Mr. John L. Hayes* was elected in his place.

Prof. Wm. B. Rogers, Prof. Locke and *Prof. Hitchcock,* were appointed a committee to confer on the subject of the time of the next meeting.

Resolved, That the subject of publication of the abstract of the proceedings of this meeting of the Association, be placed at the disposal of the chairman and secretaries of the present meeting.

A communication was read from *Mr. J. E. Teschemacher,* containing "a description of the oxide of Tin, found at the Tourmalin locality of Chesterfield, Mass."

Prof. Beck read the title of a paper "on some Trappean minerals and the general geological conclusions to be drawn from their history."

The committee on the time of meeting for 1843, reported the fourth Wednesday of April next, which was accepted.

Prof. W. B. Rogers read a paper "on the Age of the Coal Rocks of eastern Virginia." He described these strata as occupying parts of Chesterfield, Powhatan, Amelia, Henrico, and Goochland counties, and lying in basins of granite, the principal coal seam being separated by only a few feet from the floor of primary rock. In some places near the margin of the field, where alone they have been explored, the thickness of these coal rocks is upwards of eight hundred feet, but towards the centre of the principal basin it is probably somewhat greater. Throughout much of this depth they consist of coarse grits, often composed of the materials of granite so little worn as to present the aspect of this rock in a decomposing state. In this paper Prof. R. shows, on the testimony of fossils, and especially the vegetable impressions found in the grits and slates associated with the coal, that these rocks instead of being as had been hitherto supposed of even older date than the great carboniferous formation of the west and of Europe, belong in fact to a much later period and correspond nearly if not accurately with *the bottom of the oolite formation of Europe.* The prevailing fossils are of the genera *Equisetum*, *Tæniopteus*, and *Cycadites* or *Pterophyllum*, and either agree specifically or correspond nearly with those of the *oolite coal of Brora* and the equivalent beds at Whitby and other places. Prof. R. laid much stress on this determination as supplying one of the links in the geological series not hitherto discovered in this country, and as presenting a striking analogy with the abnormal development of the lower oolite in certain parts of Europe. At the conclusion of the paper, Prof. R. stated that from the fossils he has discovered in a particular division of the new red sandstone of Virginia, he expects ere long to be able confidently to announce the existence of beds in that formation corresponding to the *Keuper in Europe.*

Prof. Wm. B. Rogers communicated a paper "on the Porous Anthracite or Natural Coke of Eastern Virginia." In this paper Prof. R. investigates the cause of the peculiar texture and composition of this material, and points out the forms of vegetation

from which both it and the neighboring bituminous coal have been chiefly derived. From the position of the coke beds, as compared with those of the bituminous coal, and the frequent interlamination of the two, he proves that the non-bituminous character of the former could not have arisen from the effects of heat on a seam of bituminous coal, but must be ascribed to the thorough carbonization and desiccation of the vegetable matter before it was *sealed in* by the overlying strata.

Prof. W. B. Rogers communicated a paper "on the Connection of Thermal Springs in Virginia with Anticlinal Axes and Faults." In this paper he gives a list of more than thirty thermal springs, having an excess of temperature over the ordinary constant springs of the neighborhood of from two to nearly sixty degrees, comprising all the distinctly thermal waters which he has thus far met with in Virginia. These are all situated in the Appalachian belt, and *without an exception issue on or near the line of an anticlinal axis or a fault—or near the contact of the Appalachian with the Hypogene rocks.* Prof. R. laid much stress on the fact that the warmest of these springs were generally those which issued from the lowest formations. Accompanying the paper were a series of short sections, illustrating the geological position of a number of the most interesting of these springs.

Prof. W. B. Rogers communicated a paper entitled "Observations on Subterranean Temperature made in the mines of eastern Virginia." In this paper Prof. R. gives the results of observations with the thermometer at depths varying from one hundred to nearly eight hundred feet, all indicating an increase of temperature downwards. Some of these results procured under favorable circumstances, he considers sufficiently accurate to warrant an inference as to the rate of increase of the temperature with the depth in this region. These, it is believed, are the first observations of the kind made in the United States, and, if we except those of Humboldt in Mexico, the first in North America.

Prof. H. D. Rogers offered some remarks on the influence of pyrites on the heat of the strata.

Prof. Hitchcock read a paper entitled "Notes on the Geology of some parts of Western Asia, derived principally from the American Missionaries," and exhibited numerous specimens in illustration of his remarks.

Dr. Dana presented a copy of what was probably the first work on the geology of America, entitled "Beytrage zur mineralogepfer Keintre und des Cëstlicheu theils von Nord America und sum Gebürsge von D. Johamre David Schöpf," presented to the library of the Boston Society of Natural History. Mr. Teschemacher was requested to report on it.

Mr. Couthouy read a paper "on various icebergs as observed by him."*

Mr. James Hall read a paper "on wave lines and other markings on the surface of rocky strata in New York and other places." Association adjourned to 3½ o'clock, P. M.

Friday, 3½ o'clock, P. M.—*Prof. Silliman* in the chair. The following gentlemen were announced by the standing committee as the local committee for next year. *Dr. T. Romeyn Beck*, *Prof. E. Emmons*, Albany, and *Mr. W. C. Redfield*, New York.

A letter from *Mr. James T. Hodge*, relative to the distribution of State Reports, was read by the secretary.

A paper was read "on the Structure of the Appalachian chain, as exemplifying the laws which have regulated the elevation of great mountain chains generally;" by *Prof. Henry D. Rogers*, and *Prof. William B. Rogers.*

The authors divide their papers into two parts; Part I, being a description of the phenomena; Part II, a theory of the flexure and elevation, of the strata deduced from the preceding features of structure.

Part. I, embraces the following heads:

1st. A sketch of the physical features of the Appalachian chain, from New England to Alabama.

2nd. Predominance of southeastern dips, with an historical sketch of the previous explanations offered by other geologists.

3rd. Of the character of the flexures of the strata, and the law of their gradation in crossing the chain northwestward. Two or three new terms are here proposed for designating conditions of structure. The several prevailing forms of structure are then exemplified: (*a*,) normal flexures; (*b*,) folded flexures and inversions; (*c*,) flexures broken on passing into faults.

4th. Of the distribution of the axes in groups; remarkable parallelism of the axes in each group; great length of some axes; bending of

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* Mr. Couthouy's remarks have been already given, p. 154–165.

axes; increasing interval between the axes as we advance towards the northwest.

5th. Descriptions of a series of sections across the chain, with a table of the northwest and southeast dips which they disclose.

Part II, treats of the following theoretical topics:

1st. The force producing the flexure and elevation of the strata, was compounded of a wave-like oscillation of the crust, and a tangential pressure towards the northwest.

2nd. Theory of the origin of the supposed subterranean undulations, and of the manner in which the strata became permanently bent.

3rd. Identity of the undulations of the crust with the wave-like motion of the earth in earthquakes. This latter shown to result from an actual billowy oscillation of the surface of the subterranean fluid lava.

4th. Of the geological era of the elevation of the Appalachian chain.

5th. Analogous phenomena of flexures; axes in other countries.

A paper was next read by *Prof. Henry D. Rogers*, entitled "an Inquiry into the Origin of the Appalachian coal strata, bituminous and anthracite." It embraces the following subjects:

1st. A brief introductory sketch of the researches of other geologists in the same region.

2nd. The extent and physical features of the Appalachian coal region.

3rd. The character of the strata; (*a*,) rocks of mechanical or terrestrial origin; the laws of their gradation and distribution; (*b*,) rocks of chemical or marine origin, as limestones, &c.; the law of their distribution; inferences respecting the position of the ancient carboniferous sea and its coast.

4th. Of the coal seams, and the phenomena immediately connected with them; wide range of some of the beds; identified from basin to basin; ancient limits of the coal much more extensive; area of the great Pittsburgh seam, and law of its distribution; present and former areas of the coal strata computed.

5th. Of the intimate mechanical structure of the coal; inferences; persistency of the minor subdivisions of the coal beds inconsistent with the doctrine that the vegetable matter was drifted.

6th. Character of the strata which immediately accompany the beds of coal; prevailing nature of the under stratum, Stigmaria; different composition of the overlying rocks; these latter indicate a rapid motion of the waters, the under clay on the contrary a quiet subsidence of sediment.

7th. Beds of marine limestone in contact with the seams of coal.

8th. Theory of the origin of the coal strata; sketch of the discoveries and opinions of preceding writers; deficiencies in the hypotheses hitherto presented; condition under which the vegetable matter of the coal seams was accumulated; of the part performed by earthquake inundations in producing the mechanical strata; evidences of gradual depressions and risings of the coast of the carboniferous sea; indications of similar alternations of secular and paroxysmal movements of the earth's crust at all geological periods.

9th. Regular gradation in the proportion of volatile matter in the coal as we cross the Appalachian basins northwestward; phenomena connected with it; theory of the debituminization of the coal, and conversion into anthracite.

Prof. W. B. Rogers made a few remarks on thermal springs, as relating to the foregoing subject.

Dr. A. A. Gould, Dr. Amos Binney and *Mr. Haldeman*, were appointed a committee to report on the distribution of shells.

Some discussion on the subject of the publication of the Transactions of the Association followed.

Resolved, That *Prof. H. D. Rogers, Mr. B. Silliman, Jr.* and *Prof. L. C. Beck*, be appointed a committee to take charge of the whole matter.

The following gentlemen were invited to become members of this Association: *Prof. Johnston*, of the Wesleyan University, *Dr. Barratt*, Middletown, Ct., *Dr. James Deane*, Greenfield, Mass., *Prof. Nichols*, Union College.

Resolved, That the thanks of this Association be tendered to our distinguished chairman, *Dr. Morton*, for his services at the present meeting.

Resolved, That an invitation be given to European societies who may have the same objects in view as our Association, to send delegates to our next meeting.

Prof. Wm. B. Rogers expressed his feeling of great satisfaction at the unanimity and good feeling which had pervaded the present meeting, as well as at the straightforward devotion to science which had marked so strongly all the proceedings of its members. The Association adjourned to

Saturday, April 30th, 9 o'clock, A. M.—Association met pursuant to adjournment, *Dr. Morton* in the chair. Minutes of the last meeting were read.

Prof. H. D. Rogers presented some details in relation to the striated surfaces of the northeastern counties of Pennsylvania, and the adjacent districts of New York, proving that while the scratches which abound on the summits of all the mountain ridges in that part of the Appalachian chain observe a nearly north and south direction, answering to their prevailing course throughout New England and the country of the lakes, those on the sides and bottoms of the valleys, obey with remarkable fidelity all the local deflections which a body of moving waters would encounter among the ridges and valleys of this entangled range. In the neighborhood of the Wyoming valley, the summits of the mountains, elevated about two thousand feet above the sea, and one thousand five hundred above the valley, are covered with nearly parallel striæ, pointing a little west of south, but on their slopes, in the bed of the valley, these lines follow other directions conforming to the course which any obstructed inundation would pursue. Thus, near Wilkesbarre, the northern flank of the southern mountain, which was here exposed to the full brunt of the inundation, exhibits the grooves with a direction compounded of the general meridional one, and that of the deflecting mountain wall. High on the side of the ridge, the striæ ascend the slope obliquely, but nearer the base they are parallel to the medial axes of the valley. Near the lateral notch, in the northern mountain at Nanticoke, they point *toward* the gorge, showing that a portion of the current here came from a quarter south of east. A great northern wave would, so long as it submersed in its first impetuous rush the summits of the mountains, move forward regardless of the local inequalities of the surface, but after it had partially subsided, the long parallel ridges would present so many barriers to divide and locally deflect the now feeble remnant of the drainage. Reviewing the phenomena which he has observed, Prof. Rogers concludes that the striæ were produced by the friction of the overlying stratum of drift itself, urged into rapid motion from the north by one or more sudden inundations. From the absence near the southern border of the striated region of granitic, or other far transported northern bowlders, he infers that floating ice, while it may have been concerned in dispersing the detrital matter from the north, has had no agency in furrowing and smoothing the surfaces of the strata.

The same gentleman next adverted to the origin of conglomerates and other coarse mechanical strata, attributing them in many instances to the similar agency of the sea-wave produced by earthquakes. The wide and uniform distribution of some of the coarser rocks of the Appalachian basin, was appealed to in proof that they could have been spread out as we find them only by a sheet of water as broad as the entire margin of an ocean, breaking in successive sea-waves upon the land, and abrading and dispersing the fragmentary matter during repeated oscillations of the crust.

Prof. Rogers then added some remarks respecting grooved and polished surfaces at the contact of ancient secondary strata. He thinks he has seen unequivocal instances of these in Pennsylvania. Their production at periods when the earth's temperature was manifestly incompatible with the existence of ice, would seem to demonstrate that angular detrital matter, urged by water, is able of itself to score and polish the surfaces of rocks.

Prof. W. B. Rogers continued the illustration of this subject, by calling attention particularly to the evidences of ancient denudation and drifting action, so strikingly displayed along the place of junction of the Oriskany sandstone, (Formation VII, of the Pa. and Va. Reports,) and the subjacent limestones, (Formation VI.) In many districts the limestone has been irregularly denuded, and even to a great extent removed, and at the same time fragments of the limestone and fossils, water-worn and blended with coarse sand and gravel, have been accumulated to form the lower beds of the Oriskany rock. The rapid fluctuation in thickness of the upper limestones, as witnessed in Virginia, Pennsylvania and western New York, (near Black Rock, for example,) Prof. R. ascribed rather to the irregular force of the denudation, than to irregularity of thickness in the original deposit. He dwelt upon the epoch of the close of this limestone series, and the commencement of the overlying sandstone, as one of great interest in the history of our Appalachian rocks, marked as it is, throughout a great part of the Appalachian belt, by evidences of a sudden and great change in the physical conditions of the ancient sea, and by the proofs of attendant drifting and denuding action of extraordinary energy.

He contended that the grooved and worn surfaces of the limestone which mark the abrading action of a drift at this ancient period, together with the same phenomena observed in the rocks

of other portions of the Appalachian series, as described by Prof. H. D. Rogers and Mr. Hall, bear so striking a resemblance to those more recent effects, which have given rise of late to such deeply interesting speculations, that it would seem unphilosophical to refer the two to *different* mechanical causes. He therefore maintained, that as in the production of these ancient phenomena of diluvium or drift, it can hardly be supposed that *ice*, either floating or in the form of glaciers, could have performed any part, since the existence of ice in the ocean at that period is scarcely conceivable, we are under no necessity of resorting to the glacial, or even the glacio-aqueous theory, in explanation of the more modern phenomena of grooved and striated rocks.

Resolved, That *Mr. J. D. Whitney, Jr.* be appointed a committee to be charged with the letters from the secretary to the various foreign societies inviting their coöperation.

The standing committee nominated *Mr. N. Appleton*, of Boston, and *Prof. E. Emmet*, of the University of Virginia, as members of the Association, and they were unanimously elected.

Resolved, That the thanks of this Association be presented to the secretary and assistant secretaries for the performance of the arduous duties assigned them during the present meeting of the Association.

Resolved, That the different state geologists be requested to apply to the legislature of the states with which they are connected, for a number of copies of their reports for the use of the Association.

Resolved, That *Mr. James Hall* be added to the local committee of next year.

Resolved, That the thanks of this Association be presented to the Boston Society of Natural History for the use of their hall as a place of meeting, and for the kind attention shown to the Association by its individual members.

Mr. Couthouy read some extracts from his journal, "on the wave-like undulations of the earth's crust at all periods of disturbance from the most ancient date to the present time," instancing some modern volcanoes.

Dr. Morton, on resigning the chair during the remainder of the meeting, then addressed the Association as follows:

Gentlemen—Before we part, permit me to thank you in the most sincere and grateful terms for the honor you have done me

in permitting me to preside on the present occasion. I can assure you that I have listened with entire satisfaction and instruction to the proceedings of this body, which will fully sustain the high reputation of those gentlemen who have favored us with their communications, and at the same time establish the character of the Association at home and abroad. I look forward with confidence to its widely increasing utility, and with the most earnest desire to coöperate in your future labors, and confident of your success, I again thank you for the distinction you have thus kindly conferred upon me.

Prof. Locke was chosen chairman during the remaining part of the session.

Mr. Couthouy continued his remarks on the range of the volcanoes of the South Sea islands, and in regard to the progressive movement of volcanic action in a fixed direction.

Prof. Locke offered some remarks in regard to the Oulophyllites found on the Wabash river; also on the diamond found in Indiana on ground near and below the coal.

Dr. Amos Binney and *Dr. A. A. Gould* were added to the committee on publication.

Mr. James Hall exhibited sections on Lake Erie, showing broken strata with intermingled drift; he also spoke in regard to wood and bones found in the drift of various parts of the State of New York, particularly in the Genesee river, and in regard to the change which has there taken place in the channel of the river.

James D. Dana, A. M., of the U. S. exploring expedition, was invited to become a member of this Association.

Prof. Locke in resigning the chair remarked:—In parting with the members of the Association, I cannot refrain from adverting to the fine spirit of harmony and cordiality which has characterized the present meeting throughout all of its transactions. To preserve so desirable a condition, it is of the utmost importance that we observe, in all our communications, the most delicate principles of justice to the previous labors and publications of others. It is not sufficient that we may plead that we have not read their productions; we *must* read them, and give credit in order to preserve each his own reputation. To give credit is to acquire credit, and to withhold it is to sink ourselves into disgrace.

I will only add, that my happiness has been vastly increased by the multiplied social attachments which I have here formed. And

in this I presume I express the sentiments of all who have here had the privilege of taking each other by the hand, and of reflecting mutually that look of cordiality which is to be warmly cherished in memory's cabinet until we meet again.

Association adjourned to meet at Albany on the fourth Wednesday in April, 1843. Signed,

SAMUEL G. MORTON, *Chairman.*

CHARLES T. JACKSON, *Secretary.*

JOSIAH D. WHITNEY, Jr. }
MOSES B. WILLIAMS, } *Assistant Secretaries.*

Names and Addresses of Members of the Association of American Geologists present at the Third Annual Meeting in Boston, April 25–30, 1842.

Lewis C. Beck, *New Brunswick, N. J.*
J. T. Ducatel, *Baltimore, Md.*
Lardner Vanuxem, *Bristol, Pa.*
J. N. Nicollet, *Baltimore, Md.*
H. King, *Washington City.*
Henry D. Rogers, *Philadelphia, Pa.*
John Locke, *Cincinnati, Ohio.*
E. N. Horsford, *Albany, N. Y.*
F. Hall, *Washington, D. C.*
Oliver P. Hubbard, *Hanover, N. H.*
Charles T. Jackson, *Boston, Mass.*
J. W. Bailey, *West Point, N. Y.*
Abraham Jenkins, Jr., *Barre, Mass.*
Wm. C. Redfield, *New York City.*
Moses B. Williams, *Boston, Mass.*
James Hall, *Albany, N. Y.*
Josiah D. Whitney, *Northampton, Mass.*
Samuel L. Dana, *Lowell, Mass.*
S. S. Haldeman, *Columbia, Pa.*
H. C. Perkins, *Newburyport, Mass.*
Enoch Hale, *Boston, Mass.*
B. Silliman, *Yale Coll., New Haven, Ct.*
Robert W. Forbes, *New Haven, Ct.*
B. Silliman, Jr., *Yale Coll., New Haven, Ct.*
Charles Lyell, *London.*
Joseph P. Couthouy, *Boston, Mass.*
John L. Hayes, *Portsmouth, N. H.*
John H. Blake, *Boston, Mass.*
Augustus A. Gould, *Boston, Mass.*
Charles H. Olmsted, *Hartford, Ct.*
John Lewis Russell, *Salem, Mass.*
Francis Alger, *Boston, Mass.*
Edward Hitchcock, *Amherst, Mass.*
Ebenezer Emmons, *Albany, N. Y.*
R. M. S. Jackson, *Alexandria, Hunt. Co., Pa.*
Wm. B. Rogers, *University of Virginia.*
James B. Rogers, *Philadelphia, Pa.*
Henry Colman, *Rochester, N. Y.*
Owen Mason, *Providence, R. I.*
Amos Binney, *Boston, Mass.*
Martin Gay, *Boston, Mass.*
J. B. S. Jackson, *Boston, Mass.*

Art. XV.—*A Daguerreotype Experiment by Galvanic Light;* by B. Silliman, Jr., A. M., of the departments of Chemistry and Mineralogy, in Yale College, and Wm. Henry Goode, M. D.

In November, 1840, we succeeded in obtaining a photographic impression, by galvanic light reflected from the surface of a medallion to the iodized surface of a Daguerreotype plate. The large battery in the laboratory of Yale College, consisting of nine hundred pairs of plates, ten inches by four, was charged with a weak solution of sulphuric acid, and its poles adjusted with charcoal points, in the manner which is customary, when an intense light is to be produced by means of this instrument. Two pictures were obtained; one of which is made up of a blur, or spot, produced by the light from the charcoal points, the image of the retort-stand, on which a medallion of white plaster rested, and the image of the medallion, but the lines on its face are not given. The camera was about six feet from the charcoal points, when this impression was taken, and the medallion a little on one side, and in the rear of the points. The plate was exposed to the light about twenty seconds, and no means were employed either for condensing the light on the objects to be copied, or that reflected from them, on the lens which gave the image. The only lens employed was a French achromatic, three inches in diameter, and of about sixteen inches focal length. Another picture was taken of the medallion only, which was placed about two feet from the charcoal points, and the camera about four feet from it, and in such a position that the charcoal points did not come within the field of the lens. This picture, we regret to say, has been inadvertently destroyed. The plates used were of inferior quality, being some of the first of American manufacture.

These experiments were not published at the time they were made, because it was understood, that a gentleman distinguished for his scientific investigations, was already engaged in studying this branch of the subject, with whose researches we had no wish to interfere, and the matter was abandoned mainly for this reason. Having been informed recently, however, that this gentleman had also abandoned it, we have concluded to give this account of our experiments.

On the same occasion, an observation was made respecting the image given by the two charcoal points, when they were nearly in contact, and the battery in full operation, which we do not remember to have met with elsewhere. An image of each charcoal point is given, separate from that of the other, by a lens placed at a little distance. These two images differ remarkably in color; one is of the color of the flame afforded by the combustion of an alcoholic solution of strontia;

the other resembles in color, the flame produced by the combustion of an alcoholic solution of chloride of sodium, more nearly than any thing else with which we can compare it. The charcoal points were shifted, each to the opposite pole of the battery, without producing any change in the color of the light given off by the poles respectively. Other pieces of charcoal were substituted, in the place of those with which this phenomenon was first observed, but the difference in the color of the two images was always present, and did not seem to be connected in any manner with the particular charcoal points employed, but the yellow image was uniformly given by one pole, and the purple image by the other pole of the battery. We are under the impression, that the yellow colored image was produced from the charcoal point, in connection with the positive pole of the battery, and that the strontia colored image came from the negative pole of the battery, though of this no note was made at the time. No attempt was made to ascertain by direct experiments, whether these images possessed a different degree of power or not, in producing an impression upon an iodized plate. The difference in their color was presumptive evidence that one image, (that from the negative pole,) possessed more of the chemical rays than the other. But evidence is (we are of opinion) afforded indirectly that such is the fact. The light from both charcoal points made a slight impression on the iodized plate, before they were brought so close together as to unite in forming a general blur: these two small spots or impressions are nearly opposite, or at each extremity of one diameter of the blur, and without its circumference; one of them is more distinct than the other. Within the edge of the blur, and nearly in the same diameter with the two spots above named, there are also two impressions, darker and more strongly marked, than is the general impression made by the light from the points. One of these spots is doubtless made by the light from one point, while the other is due to the light from the other point, and one of them far exceeds the other in distinctness. Now the more strongly marked spot without the blur, and the more strongly marked one within it, are close to each other on the same edge of the blur, and are doubtless produced by the light from one and the same charcoal point. The two other spots, viz. that without, and that within the blur, which are much less distinct, are close to each other at the opposite extremity of the diameter of the blur, and are also evidently produced by the light from the other charcoal point.

Yale College Laboratory, June 20, 1842.

Art. XVI.—*Discovery of a Chambered Univalve Fossil in the Eocene Tertiary of James River, Virginia;* by M. Tuomey.

Thinking that it may have sufficient interest for the pages of this Journal, the following notice of the discovery of a Nautilus in the Eocene on James River, Va., is communicated.

Mr. Lyell during his visit to this portion of the tertiary of the United States, directed my attention to the broken link in our great cretaceous formation, presented by Virginia. At his suggestion, I determined to observe any fossils that may come under my notice, with a view to the elucidation of this interesting point. The liberality of Capt. H. H. Cocke, U. S. N., afforded me a good opportunity of examining the fossils of the well known eocene locality at Evergreen, near City Point, James River. Capt. C. at the instance of Edward Ruffin, Esq. editor of the Farmer's Register, who is engaged in the investigation of the tertiary of Lower Virginia, caused a shaft to be sunk at the base of the escarpment at the locality just mentioned. In this shaft and at a depth of about twenty feet below the level of tide water the fossil referred to was found. It was imbedded in the dark colored tenacious clay containing much green sand, common to some of the eocene strata of this region. The exterior of the shell is much decayed, but the pearly surface of the interior is well preserved, and by removing portions parallel to the aperture the concave septæ and siphunculus can be seen. It was associated with eocene species of Turritella, Crassatella, Pectunculus, a small Panopæa, and a little lower in the same stratum was found a gigantic Ostrea, measuring in height eight and a half inches, breadth five and a half inches, and weighing five pounds. The *upper* valve of this Ostrea agrees with the description of O. percrassa, Conrad, but in the lower valve the cartilage fosset is deep. The muscular impression in each valve exhibits a cavity extending upwards into the substance of the shell about two inches. A person seeing but this huge individual, and the common form of O. compressirostra, Say, found in the same stratum, would pronounce them distinct species; but I am in possession of a suite of specimens showing the intermediate forms between the two, and am convinced that this enormous fossil is but a full grown O. compressirostra.

Petersburg, Va., June 10, 1842.

Art. XVII.—*Bibliographical Notices.*

1. *New edition of Michaux's North American Sylva.*—The first volume of this work, (announced on page 377 of the last volume,) has at length appeared. The text is reprinted verbatim, from Hillhouse's translation; Mr. Nuttall's additions being reserved for the supplementary volumes. The engravings (No. 1 to 50,) which are handsomely colored impressions from the original plates, will bear comparison with those of the former edition: this, we are sorry to add, is more than can be said of the paper and typography of the text, which are truly wretched. We trust that Mr. Nuttall's portion of the work, at least, will make its appearance in a more attractive dress.

2. *Loudon's Encyclopædia of Trees and Shrubs; being the Arboretum et Fruticetum Britannicum, abridged, &c.* London, 1842.—Since our notice of the first fasciculus, (p. 376 of the last volume,) this truly valuable work has been completed, according to the original announcement, in ten monthly parts, forming a volume of 1162 pages octavo. It contains the characters, synonymy, popular names, as well as popular descriptions, of all the species and varieties of hardy trees and shrubs, now in British gardens, with directions for their culture, and notices of their uses in the arts, &c. The volume is illustrated by 2109 wood engravings, the indefatigable author having been able to obtain figures of nearly all the species described in it. Although this abridgment does not include all the interesting information to be found in the eight volumes of the larger work, "yet it contains all that is necessary for discovering the names of the different species, and for ascertaining their culture, propagation, and uses in Britain; in short, all that is essential for the nurseryman, gardener, and forester."

3. *Flora Rossica, sive Enumeratio Plantarum in totius imperii Rossici provinciis Europæis, Asiaticis et Americanis hucusque observatarum:* auctore Car. Frid. Leedebour, Bot. Prof. Emer. &c. &c. Stuttgart, (Schweizerbart,) Fasc. I, 1841, pp. 240, 8vo.—A Flora of the Russian dominions, is indeed a formidable undertaking; and, combined with a complete Flora of North America, would comprise a large part of the botany of the extra-tropical portion of the northern hemisphere. Following the arrangements of De Candolle, the first fasciculus of Dr. Leedebour's work, includes the orders from Ranunculaceæ to Cistaceæ; the former, with the Cruciferæ, occupying the greater part of the number.

4. *The London Journal of Botany;* edited by Sir Wm. Hooker. This is the title of a new monthly periodical, commencing in January last, which takes the place of *Hooker's Journal of Botany*, and is in fact, a continuation of that excellent work, in the hands of a new publisher, Baillière, who we understand, will continue the publication of this author's *Icones Plantarum.* We have more than once called the attention of our botanical readers to both these works. This indefatigable botanist has also announced, as nearly ready for publication, the first part of a new treatise upon a favorite family of plants, viz. a *Species Filicum*, or synopsis of all the known species of Ferns, with generic and specific descriptions of each, and plates containing several figures upon each plate. Only the rarest and most interesting species are to be figured, particularly such as have not yet been represented in any published work.

We may also state, that Prof. Kunze of Leipsic, is publishing, in occasional numbers, a supplement to Schkuhr's work upon Ferns, (the first volume of his *Vier und zanzigste Klasse des Linnèeischen Pflanzensystems, oder Kryptogamische Gewächse.*) Of Prof. Kunze's continuation, entitled *Die Farrnkräuter in koloriten Abbildungen naturgetsen erlautert und beschrieben*, four fasciculi have reached us, each containing twenty pages of text, (4to,) and ten finely colored plates.

5. *Kunze, Supplemente der Riedgräser (Carices) zu Chr. Schkuhr's Monographie, &c.*—We have already noticed the first fasciculus of this work, (Vol. xli, p. 374.) In the second, which has just arrived, the following species are handsomely figured, viz. *C. appressa, C. echinochloe, C. Antucensis, C. lepidocarpa, C. fuliginosa, C. vaginata, C. pediformis, C. clavata, C. provincialis, C. excelsa,* and *C. curvirostris.* C. fuliginosa is the only one of this number, known to be indigenous to North America, although C. pediformis has been found in Kamtschkatka.

6. *Memoir on a portion of the lower Jaw of the Iguanodon and of the remains of the Hylæosaurus and other Saurians, discovered in the Strata of Tilgate Forest in Sussex, (England,)* by Gideon Algernon Mantell, Esq. L.L.D. F.R.S., author of the Wonders of Geology, &c. *Fossil Remains of Turtles discovered in the Chalk formation of the Southeast of England*, by the same author.—These beautiful memoirs are a part of the Transactions of the Royal Society of London; they are illustrated by eight quarto plates, and contain full and exact descriptions of the objects to which they relate. They are marked by all that precision, discrimination and accuracy for which the author is distinguished, combining minute details of comparative anatomy, with just and

enlarged philosophical views, with respect to the extraordinary creatures which Dr. Mantell has rescued from the darkness of ages, and restored to their proper position in the creation. Those who would know the full bearing of the facts, especially those regarding the extinct saurians, must peruse the larger works of the author, his Tilgate Forest, his Geology of the Southeast of England, and his Wonders of Geology. We are truly sorry to have him terminate his memoir on the Iguanodon, by adopting the words of Cuvier: "Je termine ici mes travaux, et je laisse à mes successeurs à cultiver un champ que je n'ai fait qu'ouvrir, et qui bien certainement leur donnera encore des moissons plus riches que toutes celles que j'ai pu recueiller."*

7. *Treatise on Algebra;* by THOMAS SHERWIN, Principal of the English High School, Boston. (Communicated.)—Among the publications designed for the instruction of youth, which are daily issuing from the press, our attention has been recently directed to the elementary work named above. We think this work cannot fail to find its way to the favor of all who give it a careful perusal. The author, in his preface, modestly acknowledges his indebtedness to several preceding works of the kind, particularly that of Colburn, the favorite of the Massachusetts school-room, which, however, it surpasses in the number of examples for practice. These are so numerous, and so well chosen, that we are confident that a careful and correct solution of them will secure to the student something beyond a merely superficial knowledge of the subject. In the earlier part of the work, we were particularly pleased with several sections. One on the subtraction of negative quantities, which we remember in our school days was considered a most intricate subject; another on the "greatest common divisor," the reasons of which are seen in the school arithmetics as through a glass darkly; and a third on generalization, then held in almost reverential awe. Of the more advanced sections, we were pleased with those on negative exponents, and the unusually numerous examples in this department, will be found very useful. We were interested with the section on inequalities, and with that on ratios, of which Colburn and some other writers say nothing. The section on logarithms, without entering on the tedious calculations necessary in the actual formation of tables, gives a very good idea of the manner in which they may be constructed, and forms a happy introduction for those who desire to become better acquainted with the more abstract treatises. The miscellaneous examples at the last of the work, serve as a recapitulation of the whole, and a test by which the learner may judge of the degree of

* Recherches sur les Ossemens Fossiles, tom. v, p. 526.

thoroughness with which he has read each section. Finally, a long experience in one of the best schools in New England, has enabled the author to succeed most happily in adapting this work to the purposes of instruction.

8. *Practical Geology and Mineralogy, with Instructions for the Qualitative Analysis of Minerals;* by JOSHUA TRIMMER, F. G. S. Am. Ed., by Lea & Blanchard. pp. 527, 8vo.—We have read parts of this work, and looked over its plan. It appears to be exact, comprehensive, scientific, and practical. Its principal heads are—

Introduction; Practical Application and Uses of Geology; its discoveries not opposed to religion.

Materials of the Crust of the Earth.

Simple Bodies; External characters of Minerals; Chemical characters.

Minerals composing the Crust of the Earth; Order of arrangement of the Materials of the Crust of the Earth.

Classification of Rocks; Explanation of Terms.

Unstratified Rocks; Stratified Rocks.

Classification of the work.

Primary or Non-fossiliferous Strata; Fossiliferous strata.

Cambrian System; Silurian System.

Carboniferous System; Coal Fields of England.

Poikilitic (upper red sandstone) System.

Oolitic System; Wealden.

Cretaceous System; Tertiary System.

Modern Group, River Deposits.

Coral Formation; Igneous Rocks.

Temperature of the Interior of the Earth.

Present state of the Geological Theory.

Summary of admitted facts and inferences in Geology.

Conclusion; Postscript; Glossary; Index.

The order is good in the main. There are many advantages in introducing the igneous rocks and the dynamics of fire first, as we have then all the great agents at our command, for the interpretation of the phenomena of the stratified rocks. The work is neatly got up with a good type, and a paper reasonably white, but too thin and tender, as our American reprints are wont to be; and we have had much occasion to find fault with many republications of foreign works, on account of an inferior and slovenly style, although there are honorable exceptions. If we will persist in denying copyright to foreign authors, it is at least due to them that their reprinted works should appear in a good style.

9. *A Muck Manual for Farmers;* by SAMUEL L. DANA. Lowell, Daniel Bixby, 1842: pp. 216. (Communicated.)

Dr. Dana has long been known as one of our most accurate and learned chemists; and his professional duties, as connected with the large calico printing establishment at Lowell, have led him to make many careful experiments upon subjects bearing directly upon agricultural chemistry. He has written this work, therefore, in the full maturity of experience and judgment. His statements and reasonings are not those of a novice, but we see at once that he has looked at every point again and again, and that he gives us the final conclusions of long and patient examination. It is well known that on many points the theory of this science is not fully settled. The author, however, shows, (and this we regard as a most valuable part of his labors,) that these different views are of very little practical importance. His own peculiar opinions he states with great frankness, and merely gives a summary of arguments on which he founds his conclusions, with scarcely any personal allusion to those of different views.

The condensation of matter in this volume is one of its marked features. The amount of facts and reasonings brought into so small a compass is truly astonishing. We think it is sometimes carried to an extreme; that is, it produces obscurity. It is truly a book of aphorisms. There is so much of generalization, indeed, that we suspect the author will sometimes be misunderstood. It would not be strange if this very notice should furnish some examples.

The present work is a very original one. The author's views, generally, do indeed correspond with those of the most distinguished chemists. But he has his own method of stating, proving, and correcting them; and we have been agreeably surprised to see how straight and luminous a path he has cut through the entangled vines and brushwood of this subject. A brief account of his arrangement and elementary principles, will give our readers some idea of his manner and matter.

The whole work is divided into eight chapters. 1. The Geology of Soil. 2. The Chemistry of Soil. 3. Properties and Chemical Action of the Elements of Soil. 4. Of the Organic Constituents of Soil, with an Appendix, containing the History of Geine. 5. Of the Mutual Action of the Organic and Inorganic Elements of Soil. 6. Manures. 7. Artificial Manures and Irrigation. 8. Physical Properties of Soils. In the first five chapters he announces, defends and illustrates ten fundamental principles, which constitute the essence of agricultural chemistry. These we shall copy, with a few remarks upon some of them.

The first principle is, "*that there is one rock, consequently one soil.*" It is true, that the later rocks contain from 4 to 7 per cent. of lime and

magnesia more than the older ones; but since all of them contain enough of these and other mineral ingredients for the wants of plants, an excess of some of them cannot sensibly affect vegetation. The mineral composition of this "one soil," by a mean of numerous analyses, the author states to be, in 100 parts, 89.25 of sand, or silicates, and 0.85 salts of lime.

Thus far we agree essentially with the author. But there are some other facts, which lead us to question whether the statement of this first principle does not require modification. It cannot be doubted, in the first place, that some silicates, (varieties of feldspar, for instance,) are decomposed, both by atmospheric agencies and by growing plants, with much more facility than others; and consequently vegetation obtains from some soils the alkali, lime, and silica, which it needs, more easily than from others. In the second place, where an extensive region is underlaid by limestone, a large per cent. of the soil (from 5 to 30 in some parts of Europe) consists of carbonate of lime, and this is usually more easily decomposed than silicates, and will more readily supply carbonic acid.

The second principle is, that "*rocks do not affect the vegetation which covers them.*" Here again, while we agree with the author that this principle is generally true, far more generally so than is commonly admitted, we would suggest to him whether there are not exceptions to it, too important to be overlooked in stating it. A similar difficulty we feel in respect to his third principle, that "*rocks have not formed the soil which covers them.*" And we can conveniently, perhaps, state our exceptions to both of them in the same paragraph.

It is true that what has been called diluvial action, as well as alluvial agency, has mixed up the detritus of different formations, and spread the soil derived from one rock over others. But the great mass of the soil has in very few cases been removed more than a few miles, although single bowlders have been carried hundreds of miles. Hence, when we have gone a few miles from the borders of a formation, the soil is made up almost entirely of its pulverized fragments, removed, it may be a short distance, but still derived from precisely the same rock as that beneath it. Again, limited formations are sometimes so situated that little if any foreign detritus has been left upon them, as for instance, the trap ranges along Connecticut river. From both these causes it happens, that over a large part of our country, each rock formation of much extent, does present a peculiar soil, which the geologist easily recognizes as derived from the subjacent rock. That above granite and gneiss, for instance, is light colored and sandy; that from argillaceous and mica slate, dark colored and clayey; that from trap rock, brown and finely comminuted, but not argillaceous. We cannot but believe, therefore, that the statement, that *rocks have*

not formed the soil which covers them, is far too general in its terms. And if the preceding statements are correct, we must believe that *rocks do sometimes affect the vegetation which covers them.* We believe there is some truth in the common opinion, that limestone regions are more prolific of vegetation than any others. How very different is the Flora of the trap ranges in the Connecticut valley from that of the primary ranges of equal height on the sides of the valley! How different the oaks, maples, beeches, and hemlocks of the Hoosac mountain, from the chestnut groves of the Taconnic! Must not these differences be in part imputed to the peculiarities of the soil derived from the rocks?

The author refers to the cultivation of the different sorts of grain on all soils and in all the temperate regions of the globe, as proof that rocks do not affect the vegetation above them. But some species of plants, like some species of animals, are adapted by the Creator to almost all climates; and as man is one of them, we should expect a beneficent Providence would give the same power to those *cerealia*, which furnish him food. But let us attempt to cultivate the numerous peculiar species found in particular localities in all places where grain will grow, and we should fail in nine cases out of ten. Does this argument then from the cereals prove the point? Would not the argument from the other species referred to, be equally good on the other side? But we have neither time nor space to say all on this subject which we could wish.

The fourth principle of agricultural chemistry is that "*all soils contain enough of lime, alkali, and other inorganic elements, for any crop grown on them.*" We are constrained to say that we could wish this rule also were expressed in terms less general and sweeping. To prove it, the author has taken a strong case,—the soil of a barren pine plain. He supposes it formed of the drift of granite, which, upon an average, contains seven and a half pounds of potash, and three eighths of a pound of lime. An acre then, six inches deep, would contain 3626 pounds of lime, and 73311 pounds of potash.

Granting the premises, the conclusion is irresistible. We will admit that the soil of a pine plain may have been originally derived from the disintegration or abrasion of granite. But let almost any soil of this description be examined, and it will be found that the feldspar and often most of the mica have nearly disappeared; while little remains but grains of quartz, which contain neither lime nor alkali. Thus nearly all of these ingredients may be removed from a soil; and such we apprehend to be the fact in respect to the soil of most barren, sandy plains. Most feldspars, it is well known, decompose with great readiness; and in our opinion, it is from this mineral rather than the mica, that plants derive their supply of lime and potash.

We have made these exceptions to Dr. Dana's rules, not with a view to prove them entirely erroneous, but to suggest to the author, whether in another edition, they may not be so modified as to obviate all objections. Even in their present state, we regard them as nearer the truth than the notions that widely prevail. But we think they can be improved.

The fifth principle of agricultural chemistry asserts, that "*all soil contains sulphate and phosphate of lime.*" For the discovery of this important principle, agricultural chemistry is indebted to Dr. Dana. It was first announced in the Report on the Economical Geology of Massachusetts, written in 1837 and published in 1838, and is there accompanied by what Dr. Dana calls the "agricultural proof;" that is, the evidence derived from the composition of plants. This evidence was abundantly confirmed by the analysis of no less than one hundred and forty six soils from every variety of formation in Massachusetts. In all these soils, (except one, which was entirely made up of pure limpid quartz in the form of sand,) sulphate and phosphate of lime were found. (See final Report on the Geology of Massachusetts, Vol. I, p. 41.) The difficulty of detecting the phosphates had produced the belief that they exist only in a few soils. But the admirable rules given by Dr. Dana on this point, enable any chemist to satisfy himself that almost every plant-bearing soil contains phosphates, usually less than one per cent. In Liebig's Organic Chemistry of Agriculture, &c. published in 1840, this same principle, so far as phosphoric acid is concerned, is advanced; but whether the result of his own discoveries or of a knowledge of Dr. Dana's announcement, nearly three years earlier, does not appear.

The sixth principle is, that "*soil, consisting chiefly of one silicate, or salt, is always barren.*

The seventh principle is, that "*one base may be substituted for another in an isomorphous proportion.*" These "isomorphous substitutions in plants relate only to the vegetable or organic acids;" yet the principle holds true in respect to the inorganic parts of soils, and admits of several important applications made with great ingenuity by the author. But our limits compel us to pass them unnoticed.

The eighth principle is, that "*geine in some form is essential to agriculture.*" As discussions perplexing to the farmer have arisen in our country respecting geine, Dr. Dana has thought it necessary to be very explicit as to the sense in which he uses the term; and he has added an appendix to the chapter on this subject, detailing its history. He uses the term in two senses, viz. an agricultural sense and a chemical sense.

"In all its forms," he says, "it is agriculturally one and the same thing. They are all included in the terms humus, or mould, or geine.

Geine, in its agricultural sense, is a generic term. It includes all the decomposed organic matter of soils." p. 62. In a chemical sense, he maintains that "the great mass of organic matter of soil is a well defined chemical compound termed geine, consisting of carbon, hydrogen, and oxygen." p. 60.

Agricultural geine, then, we understand to be the equivalent of the humus and mould of other chemists, and to embrace the extract of mould, the humic acid, humin, crenic and apocrenic acids, and whatever other compound has resulted from the decomposition of the organic matter of soils. Agriculturally, these may be all regarded as the same thing; and the farmer may be assured, that "differ as opinions may about its ultimate chemical constitution and the mode of action of geine, whether by being taken up as a solution of geine or geates, or only as a source of carbonic acid, the great practical lesson of all agricultural experience, teaches that geine is essential to the growth and perfection of the seed; that without geine crops are not raised. Geine is as essential to plants as is food to animals." p. 61. Some of the ablest chemists, as Liebig and Graham, do not admit the distinct existence of crenic and apocrenic acids, enumerated above as compounds found in soils: others regard extract of mould and humin as mere forms of humic acid. But such questions are of little practical agricultural importance, and may be safely left to the chemists to settle. Dr. Dana has an opinion on these points, and his *chemical geine*, as we have seen, is "a well defined compound," embracing the humic acid, the humin and extract of mould of Berzelius, and the sacchulmic acid and sacchulmin of Liebig. Berzelius, it is well known, originally gave the name geine to this compound, in the French edition of his works published in 1832; and the same name is retained in Esslinger's French translation of his *Traite de Chimie*, published in 1840, which lies before us. But very recently, it would seem, he has substituted *humic acid* for geine; a mere change of name, but not of opinions respecting the nature of the compound. Indeed, the distinct and definite nature of this substance seems to be admitted by as high chemical authority as almost any organic compound can claim, although the name is not yet settled.

The ninth principle of agricultural chemistry asserts that "*carbonic acid and the carbonates, decompose the earthy, alkaline, and metallic silicates of soils.*" This is an exceedingly important principle, and applicable especially to the agriculture of primary regions.

The tenth principle is, that "*the base of all salts acts ever the same in agriculture. Peculiarity of action depends on the acid of the salt.*" This the author regards "in all its length and breadth, *as the great practical principle of agricultural chemistry.* It opens veins rich in

results, more precious than mines of gold." This is no idle boasting. The author in a chapter of thirty seven pages, on *the Mutual Action of the Organic and Inorganic Elements of Soil*, has opened some of these mines—enough to bring up to view rich samples of the golden ore. In plain language, we have never met with so luminous and satisfactory a view of the mutual and complicated action of silicates, salts, and geine, as this chapter presents. Gladly would we lay before our readers an analysis of its contents, but we must forbear.

Similar remarks will apply to the still longer chapter on manures, and to that on artificial manures. For the numerous analyses by the author of several sorts of manure, and the important results he hence deduces, and for the important suggestions he makes as to artificial manures, he deserves the gratitude of his country and the patronage of its government. For if heeded by the farmer, the doubling at least of our agricultural productions will undoubtedly be the result, and few farmers can read these chapters without being convinced that "rivers of riches run away from farms from want of attention to saving that which ordinarily is allowed to be wasted." p. 175.

In conclusion, we can cordially recommend this work to our agricultural friends for its practical character. It is not saying too much to assert, that Dr. Dana has done for the farmer in this treatise, what Dr. Bowditch did for the sailor when he published his Practical Navigator. In this respect this treatise contrasts strongly with such a work as that of Liebig on the Organic Chemistry of Agriculture, &c. which, notwithstanding its originality and the philosophical beauty of its theories, is apt to make the impression upon the farmer that he is not at present to expect much from agricultural chemistry but ingenious conjecture. We are sure that Dr. Dana's work will remove this impression, while on the other hand, the chemist will see in it evidence of the rapid advance of this science. Within two years, three able European chemists, Liebig, Daubeny, and Johnston, have given to the world most mature and valuable treatises upon it; and now we have a cis-Atlantic effort, which will not suffer by a comparison with any other. Truly the genius of agriculture may exult in the bright prospects that are opening before her.

10. *Address delivered at the Anniversary meeting of the Geological Society of London, Feb.* 18, 1842; *and the announcement of the award of the Wollaston Medal and Donation fund for the same year;* by Roderick Impey Murchison, F. R. S., President of the Society.—The annual addresses at the anniversaries of the Geological Society of London are full of instruction. That of the present year is not a whit behind its predecessors, and is every way worthy of its distinguished

author. With the frankness and generosity which belong to his character, he bestows upon *Leopold Von Buch*, the veteran geologist of Prussia, the well deserved honor of the Wollaston medal, and annexes to the annunciation a sketch of those numerous and important labors of his, which are less known than his great classical works.

He announces also the bestowment, by the council of the Geological Society, of the Wollaston fund for the past year upon Mr. Morris, to assist him in preparing a table of British organic remains. In the painful duty of naming members who have died during the late year, he mentions, with just eulogy, the name of Sir Francis Chantrey, the great sculptor; Mr. J. E. Bowman, whose valuable papers in the Transactions of the Manchester Geological Society we have perused with much interest and advantage; also, Mr. Thomas Edington of Glasgow, Mr. Snow of Highgate, Dr. Yelloly, and the Rev. Mr. McEnery.

The President having returned from a second geological tour through Russia, (mentioned in Vol. XLI, p. 207,) announces with well merited satisfaction, the vast expansion of the Silurian system in that empire, and in many other parts of the world, but above all other foreign countries, he remarks, " North America appears to be rich in rocks of the same age. Of this fact, indeed, the Geological Society received the clearest evidence in the excellent section of Mr. James Hall, and the fine suite of American minerals which accompanied it." In a note he adds, " I was very much struck with the clear, unpretending and workmanlike manner in which Mr. Hall had the kindness to communicate his views to myself, respecting the Silurian and other Palæozoic rocks of the United States."

He objects, and we think with good reason, to an attempted subversion of his own nomenclature of the lower fossiliferous rocks, which he, being the first thoroughly to explore, had a full right to name; the geological world has acquiesced in the designation, and we trust that even the justly respected authority of Mr. Phillips will not avail to subvert it.

Of a recent work by Mr. Hugh Miller, in a 12mo. with plates and colored sections, entitled, " *The Old Red Sandstone, or New Walks in an Old Field*," he thus speaks in terms of merited commendation: " From a pretty accurate acquaintance with the tracts from which Mr. Miller has taken his title, I can assure you, says Mr. Murchison, that the walks of this author had been little trodden, and that his claims to originality are very just. It is impossible to peruse these pages without delight, in tracing how the strong mind of Mr. Miller has enabled him to rise, step by step, from the stone quarry of his—and I may add my own—native county, Ross-shire, to a place in literature and science which few reach,

even with all the support derived from an expensive education; or without admiring the ability with which this unassisted observer first succeeded in putting together the dislocated fragments of the very singular fish, called Pterichthys, by Agassiz, long before that creature was first understood. Look again to the clear and general view which this author takes of the greatest of Scottish deposits, and how well he conveys to unpracticed readers a true idea of its position, importance and divisions, and you will agree with me, that in Mr. Hugh Miller we have to hail the accession to geological writers, of a man highly qualified to advance the science. Few persons, and too often least of all those who are, if I may so speak, professed geologists, succeed in imparting to others, who have not studied the science, a clear conception of their views. In this respect the character of Mr. Miller's work is admirable, for it portrays the means by which the author acquired his knowledge, and from its persuasive manner, is worth to a beginner, a thousand didactic treatises." Professor Buckland, before the British Association, said, that "he had never been so much astonished by the powers of any man as he had been by the geological descriptions of Mr. Miller. That wonderful man described these objects with a felicity which made him ashamed of the comparative meagreness and poverty of his own descriptions, which had cost him hours and days of labor. He would give his left hand to possess such powers of description as Mr. Miller, and if it pleased Providence to spare his useful life, he, if any one, would certainly render the science attractive and popular, and do equal service to theology and geology."

In our turn we take leave to add, that this admirable work, the production of a man who obtained his geological knowledge while working, day by day, as a laborer in a quarry of the old red sandstone in the northeast part of Scotland, evinces talent of the highest order, a deep and healthful moral feeling, a perfect command of the finest language, and a beautiful union of philosophy and poetry. No geologist can peruse this volume without instruction and delight. It affords an admirable synopsis of the formations between the granitic schists and the coal measures, and indeed embraces an enlarged and highly philosophical view of the science, and of its relation to the Creator.

The splendid labors of Mr. Owen, and of Dr. Mantell, on paleontology, are duly appreciated by Mr. Murchison, as are the researches of Sir Philip Egerton, Mr. Strickland, Mr. Trimmer, and others.

We have not space even to name the deserved notices which are bestowed on continental geology—the grand geological map and descriptive volumes of France, and the Paleontology of D'Orbigny; the new works of the veteran Humboldt; the labors of the Prussian, Russian, Belgian, German, Swiss, and Italian schools; the local societies and

labors of England, Scotland, and Ireland, and the wide-ranging researches that are in progress in this country.

Mr. Murchison takes honorable notice of the labors of Mr. Lyell among us, and of the co-operation of American geologists with him in carrying out his personal review of the great features of our geology. We must, however, find room, in the very winding up of our number, for adding, that Mr. Murchison has reviewed, with a faithful severity, the wide extension attempted to be made of the beautiful glacial theory of Agassiz, so splendid and satisfactory in its application to the Alps, and to all other regions where glaciers exist, or can have existed in past ages. This great subject, and with it that of drift and bowlders, the President discusses with his accustomed ability and independence, and prescribes some wholesome restraints to those whose imaginations would allure their judgment to unsustainable conclusions.

We are not willing, however, to omit the following citation, with which we shall conclude our notice:

"The other point to which I allude, and bearing at once on this view, is a discovery which our librarian has just made without quitting the apartments which he so truly adorns. In the American Journal of Science for the year 1826, vol. x, p. 217, Mr. Lonsdale has detected a short, clear, and modest statement, entitled 'Remarks on Bowlders, by Peter Dobson,' which, though little more than one page in length, contains the essence of the modified glacial theory at which we have arrived after so much debate. First describing in a few lines the manner in which large bowlders, weighing from ten cwt. to fifteen tons, were dug out in clay and gravel, when making the foundations for his own cotton factory at Vernon, and seeing that it was not uncommon to find them worn, abraded, and scratched on the lower side, '*as if done* (to use his own expression) *by their having been dragged over rocks and gravelly earth in one steady position*,' he adds this most remarkable sentence: '*I think we cannot account for these appearances, unless we call in the aid of ice as well as water, and that they have been worn by being suspended and carried in ice over rocks and earth under water.*' To show also that he had read much and thought deeply on this subject, Mr. Dobson quotes British authorities to prove, that as ice-floes constantly carry huge masses of stone, and deposit them at great distances from their original situation, so may they explain the transportation of foreign bowlders to our continents.

"Apologizing therefore for having detained you long, and for having previously too much extended a similar mode of reasoning, I take leave of the glacial theory in congratulating American science in having possessed the original author of the best glacial theory, though his name had escaped notice; and in recommending to you the terse ar-

gument of Peter Dobson, a previous acquaintance with which might have saved volumes of disputation on both sides of the Atlantic."

11. *Transactions of the Manchester Geological Society, Vol. I.*—This volume of two hundred and thirty-six pages, 8vo, is illustrated by nine beautiful plates. The subjects treated of are,

I. On some of the Objects and Uses of Geological Researches. By Dr. Black.

II. Sketch of the Geology of Manchester and its vicinity. By Mr. E. W. Binney.

III. Observations on the Lancashire and Cheshire Coal Field, with a Section. By Mr. E. W. Binney.

IV. Remarks on the Marine Shells found in the Lancashire Coal Field. By Mr. E. W. Binney.

V. On the Origin of Coal; and the Geological Conditions under which it was Produced. By Mr. J. E. Bowman.

VI. Observations on the Characters of the Fossil Trees lately discovered on the line of the Bolton Railway, near Manchester. By Mr. J. E. Bowman.

VII. On a White Fossil Powder found under a Peat Bog in Lincolnshire, composed of the siliceous fragments of microscopic parasitical Confervæ. By Mr. J. E. Bowman.

VIII. On the Fossil Fishes of the Pendleton Coal Field. By Mr. E. W. Binney.

IX. On the Economy of raising Water from Coal Mines, on the Cornish principle. By Mr. W. Fairbairn.

Note to the same.

X. Notice of Upper Silurian Rocks in the vale of Llangollen, North Wales; and of a contiguous eruption of Trap and Compact Felspar. By Mr. J. E. Bowman.

XI. Description of some New Species of Fossil Shells, found chiefly in the Vale of Todmorden, Yorkshire. By Capt. Thomas Brown.

Description of Plates.

Most of these memoirs we have attentively read, and all we have looked over with care. Rarely have we found more interesting and valuable matter within the same compass. The memoirs are accurate in observation, exact in science, sound in reasoning, elevated in moral sentiment, and dignified in style. There is in them a marked character of manliness and utility as well as of science; and Manchester, both by this volume and the productions of its earlier philosophical society, as well as by its deceased Henry, and by its Dalton, and the other living men who cultivate useful knowledge, has redeemed itself from the character of being a mere emporium of manufactures and trade.

The Geological Society has for its head the Right Hon. Lord Francis Egerton, supported by a list of officers, several of whom appear as authors in this volume of Transactions. We observe with much regret, among the dead, whom Mr. Murchison has commemorated in the annual address before the Geological Society of London, the name of John Eddowes Bowman, F.G.S., L.S., &c. Four of the eleven papers in this volume are from his pen. They are very valuable and instructive, and

derive a painful interest from being his last contributions to science. His account of the fossil trees of the coal formation, excavated within a few miles of Manchester, in digging for the rail-road to Bolton, is particularly important, and is rendered perfectly intelligible by a good section with the trees *in situ.*

12. *Fourth Report of the Agriculture of Massachusetts, counties of Franklin and Middlesex;* by HENRY COLMAN, Commissioner for the Agricultural Survey of the State. Boston: Dutton & Wentworth, State Printers. 1841. 8vo, pp. 528.—Mr. Colman is too well known to all our readers who value the advancement of the noblest human occupation, to need praise at our hands. This is the fourth, and we are sorry to say the *last* report, from his hand, of Massachusetts agriculture. We should be surprised that a state so enlightened as to institute this survey, should stop it as it were in the bud, were we not informed that the arrest was accomplished by a legislative committee, not one of whom had ever read a page of the three former reports of the able commissioner. Under these circumstances, no one can doubt but the survey which has already done so much for the State will be renewed. We are assured by gentlemen highly competent to judge, and whose practical opinion among farmers is worth every thing, that the present report is by far the most important agricultural document ever produced among us. From our own perusal, we perceive that the amount of condensed and classified information is very great, and the quotations of actual experience from the best farms in the State, give the work a standard value very different from works of purely speculative contents. It is particularly full on the dairy, and the improved breeds of cattle.

We hail with extreme pleasure the revival of agriculture in this country, looking upon it as the first, most important and happiest of merely human occupations. We ventured to predict in a notice of Liebig's Agricultural Chemistry, Vol. XL, p. 177, that the publication of that work would form a new era in agriculture. We may appeal to the history of the two past years for the truth of that statement. The press has literally teemed, during that period, with books on various departments of agriculture, but especially on agricultural chemistry. There are now not less than six or eight of these new publications on our table, hardly yet dry from the press, and almost every journal announces some new one, or new editions of those already out. The ablest men, in all parts of the world, no longer consider the subject unworthy their attention. Every thing indicates that the public mind has become thoroughly alive to the importance of its greatest physical interest, and we may confidently anticipate the best results for science and mankind.

13. *Letters and Notes on the Manners, Customs and Condition of the North American Indians, written during eight years' travel among the wildest tribes of Indians in North America in* 1832, '33, '34, '35, '36, '37, '38, '39; by George Catlin. In two volumes, pp. 534, with four hundred illustrations carefully engraved from his original paintings.

This is a very extraordinary work—one which no reader who has once begun to peruse, will willingly lay down until it is finished.

It presents a high example of a peculiar kind of enthusiasm, in a man who possessed fine qualifications for his wild, romantic undertaking; which, however, appears chastened into right-minded sobriety, when we duly estimate the benevolence which beams in every page.

Mr. Catlin is now too well known on both sides of the Atlantic Ocean to justify an introduction by us to the public. Thousands on thousands saw his pictures of Indian features, persons and costume, with his living delineations of the noble scenery of their wide-spreading country; which with their utensils, arms, clothing, lodges, and even preserved scalps of those whom they slew as enemies, form a most unique and interesting museum; and thousands listened also in New York, to Mr. Catlin's spirited and graphic conversation and lectures, before his embarkation for Europe.

This museum, now removed to London, is probably lost forever to this country, and with it the magnificent Chinese museum of Mr. Nathan Dunn,—two collections so peculiar that they can never be replaced, and of which the final departure for the world's great metropolis, redounds little to the honor of our country.

Mr. Catlin has raised a monument to the memory of the American Indians, which will tell to posterity the incredible story that native nations of noble character have been destroyed by the invasion of war, by pestilence, fraud and alcohol, all proceeding from those who call themselves Christians, and a few among whom have vindicated their claim to this character by acts of truly Christian benevolence.

Our space will not allow us to enlarge upon this very interesting work, and we are so much gratified as well as pained by its perusal, that we feel no disposition to criticise little faults of style, or perhaps even to wish for more condensation, where the free and flowing subjects seem to justify, if not to require the same spirit in the author, traveller, adventurer, artist, philanthropist—all combined, in a manner so attractive, that we would not hazard any material alteration.

In the wilds of nature, among snowy mountains and boundless prairies and endless rivers, innumerable herds of wild horses, antelopes and buffaloes—and among tribes of Indians, as free and reckless as they, we catch the spirit of the adventurer and hurry along with him with dizzy velocity. These topics however, we must leave to the pen of literature, while we have to regret that we have no room at present to extract and condense

many facts of deep interest to some of the sciences to which our work is devoted. Mr. Catlin, before he went abroad, gave us a valuable paper on the Indian pipe quarry, (Vol. XXXVIII, p. 138,) and we were much interested, during our interviews with him in New York, by the bold geological features, so vividly sketched on canvass by his pencil. We are now permitted to advert to only a single fact. Upon the upper waters of the Missouri there are vast regions bordering on the river, where the rain and snow floods have cut out of the high tertiary banks, the most extraordinary groups of cone-shaped and turreted hills, which are merely sections made by water, of a most extensive and beautiful tertiary or recent secondary formation.

The beds of clay, sand, gravel, loam, lignite and gypsum, which we well remember to have seen portrayed in lively and contrasted colors in Mr. Catlin's oil paintings, are arranged with the most exact regularity, and remain so perfectly horizontal, that no convulsion can have ever disturbed them, since they dropped from the waters which, in gone by ages, laid them down where we find them now, in brilliant sheets of strata. The lignite had been taken for coal, and it is not at all surprising, since it resembles coal so strongly in color and form. A vast country of many thousands of square miles lies in prairie, or covered by pumice, and upon the unmutilated surface presents little variety of structure; but, where it has been worn by the torrents that rush into the great river, the water has cut down these beautiful strata so as to form innumerable gorges and ravines, from the summit grass to the river's level, in altitudes varying between two and six hundred feet. The forms are, in general, elegantly symmetrical cones, either grass-clad from base to summit, or with the naked strata striped and colored in beautiful and definite contrast. The cones stand side by side and base to base, with only winding passages among them. In various instances, they are cut into pillars or columns, crowned by capitals, which are the remains of the upper strata of firmer consistence—giving to these vast mounds a castellated aspect; or, the tough tenacious clays are carved into sharp pointed minarets, like the aiguilles of the Alps, and they are grouped in such profusion, and often at the foot of the castellated pyramids and cones, that the entire assemblage rivets the eye as upon magnificent ruins of art, which, however, they entirely surpass in colossal dimensions, and exuberance of natural ornament.

From Mr. Nicollet, the accomplished scientific traveller of the west, we may expect some notices of the fossil contents of these extraordinary strata, which, from what little we have already seen, must be rich in fossils of the tertiary and the chalk.* Mr. Catlin favored us with

* Dr. S. G. Morton of Philadelphia, has already published a notice of the cretaceous fossils collected by Mr. Nicollet. (Vide this No. p. 149.)

a fine fossil turtle and the jaw of a Saurian, and the Association of American geologists saw with admiration at Philadelphia in April, 1841, the beautiful chalk fossils of Mr. Nicollet, many of them superbly adorned with their pearly coats—their nacre being almost untarnished, after the lapse of ages.

14. *New Works in Science.*—We find on our table a number of works of much interest, and all demanding more or less attention at our hands. At present we must confine ourselves with giving the titles only of some of the most important:

Memoir of the Geological Survey of the State of Delaware, including the Application of the Geological Observations to Agriculture. By James C. Booth, A. M. Dover, Delaware, 1841. 8vo. pp. 188.

Report of the British Association for the Advancement of Science for 1841, (or Vol. 10,) 8vo. pp. 480. London, 1841. J. & E. Taylor.

Bailey's Review of Berkley's Theory of Vision. London, 1842. 8vo. pp. 139.

Scientific Memoirs, Vol. III, Part 10. April, 1842.

Zoological Contributions, by S. S. Haldeman. No. 1, Feb. 1842, on some American species of Hydrachnidæ.

Coup d'Oeil sur l'Etat Actuel de nos connaissances sur Electricité, par M. A. de la Rive. From the Bibliotheque Universelle de Geneve.

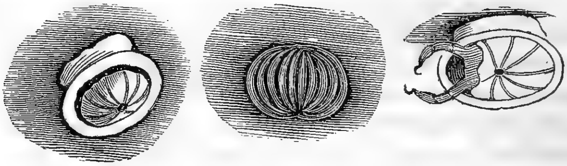
Papers on Practical Engineering, published by the Engineer Department. Bitumine, its varieties and uses. Compiled from various sources by Lt. H. W. Halleck, under direction of Col. J. G. Totten. Washington, 1841. 8vo. pp. 206, with 3 plates.

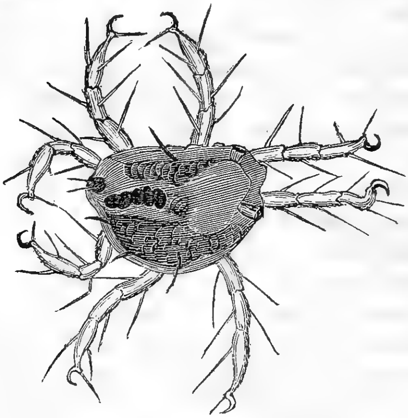
MISCELLANIES.

FOREIGN AND DOMESTIC.

1. *Microscopic Fungus.*—The fungus described by Prof. Bailey (in this Journal, Vol. XLII, p. 195, Jan. 1842) as having been received from England from Dr. Mantell, and discovered also by Prof. Bailey in the neighborhood of West Point, has since been shown to be an ACARUS, the *red fluid* arising from the puncture of the enclosed animal when in an embryotic state. In the spring of this year, the discoverer, Mr. White, found to his great astonishment that each of the supposed fungi, contained an *Acarus* of a red color, having six legs. At a late meeting of the Microscopical Society of London, Mr. White produced specimens of the animal in various states of development. The figures will show four different stages of disclosure of this so-called fungus, as it appeared to Dr. Mantell. The creature is more symmetrical than Miss

Mantell has drawn it, when seen in a more favorable point of view, but it was necessary to fix the animal in a globule of gum to keep it within view, and that has rather distorted the body; still the representation is very correct, and sufficient for the purpose. We regret that the colors cannot be seen in the engraving, as they are quite brilliant.





Prof. Bailey states that this Acarus is exceedingly common in this country, and he found its eggs near Salem, Mass. in May, as well as at West Point.

2. *Soirées of the President of the Geological Society of London*, R. I. Murchison, Esq., Belgrave Square.—The splendid mansion of this distinguished geologist was thrown open to the Fellows of the Geological Society on Saturday evening, April 23—the first of six soirées given by the President. All the savans of London were present and many distinguished foreigners. On the tables was a highly interesting series of minerals and fossils from Russia, collected by Mr. Murchison during his recent tour from St. Petersburg to the Ural Mountains. The number and variety of specimens were very great.

3. *Testimonial to Dr. Mantell.*—The clergy and principal inhabitants of Clapham Common and its vicinity, have testified their sense of the advantages derived from Dr. Mantell's lectures on physiology and other branches of science, by very appropriately presenting to that gentleman, who is one of the most persevering and successful cultiva-

tors of science in this country, through the rector, a "microscope and apparatus, value one hundred guineas; with the following inscription: 'Presented to Gideon Algernon Mantell, Esq., LL. D., F. R. S., &c. by his friends in Clapham and its vicinity, in testimony of their grateful sense of his kind and effective exertions among them for the advancement of scientific knowledge, Feb. 3, 1842.'"—*From the Lancet,* (*medical journal, London.*)

4. *Steam Navigation in the Pacific.*—In Vol. XLI, p. 358, we gave some account of the success of Mr. William Wheelwright in the efforts made by him to establish navigation by steam along the coasts of Peru and Chili.

Letters from him to the senior editor, dated at Guayaquil, October, 1841, and on board the steamer Chili, December 5, 1841, furnish the following additional particulars. In the letter of October, he says:—

"I now take the liberty of sending you a sample of coal from the isthmus of Panama, which you will find bearing a remarkable resemblance to that of Talca—a parcel of which I forwarded to you. We have not been able to discover any coal in the mining districts or rather the mineral districts of Peru or Chili, but the mines in Talca are every day improving in quality, and the quantity is unlimited: in fact, the whole southern country is nothing but a mine of coal. I have sunk a shaft about fifty five feet through a bed of sandstone, and there are already evident geological signs of the vein existing below. The rains have deterred me from continuing the work during the winter, but I intend resuming it in the spring.

"The progress of our steamers here has been in a measure interrupted by an unfortunate accident which occurred to the Chili—she having struck on a ledge of rocks—which has delayed her six months, but I hope in a few weeks to see her again at work.

"The prosperity of the enterprise is no longer doubtful. The coal of Talca will not exceed \$2 50 per ton, put on board. The number of passengers has been doubled already, and one year more will fill the steamers constantly. I am waiting the arrival of one more steamer to complete the line to Panama."

The second letter we insert entire, as all the information it contains is interesting.

Steamer Chili, December 5, 1841.

My dear Sir—I am exceedingly indebted for your letter,* dated July 20, 1841, and for the information it contains on the subject of coal, which is most satisfactory. Since my last, we have mined about

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* See this Journal, Vol. XLI, p. 362.

three thousand tons; the veins continue about the same, but the quality of the coal is much improved. We now find that the consumption is but little greater than the common English coal, and it is so favorable to our boilers and fire bars, that on the whole I consider it preferable for our purposes to any coal from England.

I am now expecting some miners from England, and intend opening some new mines as soon as they arrive, so that in case of accident my resources will not fail me. With the exception of a sad accident which occurred to this steamer, which I have since had repaired, our steam operations have gone on very prosperously. I have now the line extended to Guayaquil, and a sailing packet fills up the space to Panama until another steamer arrives from England, of which I am in anxious expectation, when the whole line will be completed, and a steam communication established between Great Britain, Chili and Peru.

It would be difficult to form an estimate of the value of steam on this coast. On my recent return from Guayaquil to Lima, in this steamer, which occupied five days, I had an opportunity of observing it. One vessel sailed four weeks before us, and was thirty six days. Another Baltimore clipper also sailed from Guayaquil a few days before us, and was twenty five days, which I consider the average passage of sailing ships from Guayaquil to Lima. From Arica to Cobya we employ two days. A ship which sailed from the former port we passed on the passage;—she finally arrived in twenty two days. These are every day and most common occurrences, and such extremes of sailing ships *versus* steam ships, can be found on the Pacific.

For some years past, the subject of opening a road across the Isthmus has been constantly before the public, but not a single step has been taken as yet to effect it. I have written to the government of New Grenada, offering to take the contract,—which, if I succeed in obtaining, I hope to render effective. I have the honor to remain, respectfully, your most obedient servant, WM. WHEELWRIGHT.

5. *U. S. Exploring Expedition.*—The U. S. corvette Vincennes, flag ship of the exploring expedition, arrived at New York, June 13, from a cruise of nearly four years—officers and crew all well.

The U. S. brigs Porpoise and Oregon, (bought to take the place of the Peacock, lost at the mouth of the Oregon, July, 1841,) sailed from St. Helena on the 24th of April for New York, via Rio de Janeiro, and may be expected soon.

The tender Flying Fish was sold at Singapore, having been nearly used up in the service, and her officers and crew transferred to the other vessels of the squadron.

The Sea Gull, with all on board, was lost in the winter of 1838–9.

The exploring squadron sailed from the United States on the 18th of Aug., 1838, and has been absent nearly four years; during which time, the different vessels have sailed about four hundred thousand miles. The expedition has thoroughly executed every part of the duties confided to it by the government.

The ports, harbors, islands, reefs, and shoals named in the list annexed, have been visited and examined or surveyed.

The positions assigned on the charts to several vigias, reefs, shoals, and islands, have been carefully looked for, run over, and found to have no existence in or near the places assigned them.

Several of the principal groups and islands in the Pacific ocean have been visited, examined, and surveyed; a friendly intercourse, and protective commercial regulations, established with the chiefs and natives; aggressions on our citizens and commerce redressed, and a justly merited punishment meted out in some flagrant cases of unprovoked and cold-blooded murder.

The discoveries in the Antarctic ocean (Antarctic continent-observations for fixing the southern magnetic pole, &c.) *preceded* those of the French and English expeditions.

The report which has been in circulation, that Capt. Ross had run over some portion of the land discovered by this expedition, is unfounded. No land to the eastward of 160° of E. longitude was discovered, seen, or claimed, by the American expedition; as appears by Capt. Wilkes's report to the Navy Department, published in 1840, after the return of the squadron to New Zealand. If this statement originated with Capt. Ross, based upon the particular chart of the Antarctic ice, and discoveries of land, with the full explanatory letter which was furnished him by Capt. Wilkes, (previous to Capt. Ross's antarctic cruise,) he (Capt. R.) must have taken that portion of land reported to have been seen by Bellamy in 1839, which was represented on it, as being in 163° to 165° east longitude or thereabouts, and which the American expedition had never seen or heard of until its return to Sydney, N. S. W. after their discoveries in the Antarctic ocean.

Capt. Ross, according to his report, has never passed over, or gone so far west as 160° east, in latitude 67° south; consequently he could not have seen the land discovered and claimed by the American expedition, but seems to have run over the position where land is reported to have been seen by his own countryman, Bellamy.

The expedition, during its absence, has also examined and surveyed a large portion of the Oregon territory, as well as a part of Upper California, including the Columbia and Sacramento rivers, with their various tributaries. Several exploring parties from the squadron have explored, examined, and fixed those portions of the Oregon territory least

known. A map of the territory, embracing its rivers, sounds, harbors, coasts, forts, &c., has been prepared, which will furnish the government with a mass of valuable information relative to our possessions on the northwest coast, and the whole of Oregon.

Experiments were made with the pendulum on "Mouna Loa" on the island of Hawaii, one of the Sandwich Islands, at a height of 14,000 feet above the level of the sea. Topographical surveys and views were made of some of its active and most extensive craters.

Experiments have been made with the pendulum, magnetic apparatus, and various other instruments, on all occasions; the temperature of the ocean, at various depths, ascertained in the different seas traversed, and full meteorological and other observations kept during the cruise.

Charts of all the surveys have been made, with views and sketches of headlands, towns or villages, &c. with descriptions of all that appertains to the localities, productions, language, customs, and manners.

At some of the islands, this duty has been attended with much labor, exposure, and risk of life—the treacherous character of the natives rendering it absolutely necessary that the officers and men should be armed, while on duty, and at all times prepared against their murderous attacks. On several occasions boats have been absent from the different vessels of the squadron on surveying duty, (the greater portion of which has been performed in boats,) among islands, reefs, &c. for a period of ten, twenty, and thirty days at one time; on one of these occasions, two of the officers were killed at the Fiji group, while defending their boat's crew from an attack by the natives.

The scientific gentlemen have been actively engaged in their various departments, and subject to all the exposures incident to researches among dangerous and hostile savages. Mr. Hale, the philologist of the expedition, was left at the Columbia river, for the purpose of prosecuting his labors among the different tribes of the Oregon territory, and may be expected home overland early in August.

Several islands not laid down in the charts have been discovered, on one of which the natives offered worship, evidently believing that their visiters had come from the sun.

The Sooloo sea has also been examined, several islands found to have been erroneously laid down on the charts, and others not laid down at all. Protective commercial regulations established with the Sultan of Sooloo, and a correct chart made of a feasible and short route for passing through these seas towards China, against the northeast monsoon.

Although the officers and crew of the expedition have been exposed to every variety of climate, the general health of the squadron has been without a precedent. But one officer (Mr. Vanderford, master's mate, who died on the passage home) and only eight of the men, have died from disease.

The officers, scientific gentlemen, and men, have been constantly employed, as will appear by the labor performed, and the results of the cruise.

In addition to the extensive collections already received from the expedition, the Vincennes has now on board a large and valuable collection, including several boxes of live plants, bulbs, &c., collected in the Pacific, Sooloo, Philippines, Singapore, Cape of Good Hope, and St. Helena.

List of ports, reefs, islands, &c., visited, examined, or surveyed, by the U. S. Exploring Expedition, during the cruise.

Ports visited.—Madeira; Port Praya, Cape de Verde; Rio Janeiro, Brazil; Valparaiso, Chili; Callao, Peru; Sydney, New South Wales; New Zealand; Manilla, Laconia Island; Singapore; Cape of Good Hope; St. Helena.

Reefs, shoals, &c. looked for and not found.—St. Ann's shoal, Maria rock, Boni Felix shoals, Bonnetta shoals, Hartwell reef, Patty's overfalls, Warley shoal, French shoal in two positions, Triton bank, Vigia, Bowvett's Sandy isles, submarine volcano of Kraisenstene.

Islands surveyed with the harbors.—*Low Archipelago.*—Clermont de Louvaire island, Serles island, Minerva do., Hondens do., Wyhite do., Otookoo do., Kings do., Raraka do., Vincennes do., Carlshoff do., Waterland do., Wilson and Peacock do., Rurick's chain, Prince of Wales, Kraisenstene's.

Society Islands.—Matie, Otahite and harbors, Eimeo: Bellinghausen, Rosa.

Navigator Group.—Manucah, Lutuella, Upolu, Monoko, Apposimo, Savaii, Wallis's island, Horn, Lord North's, Macquarie's, Eooa, Tongataboo, Harpai, Turtle.

Fiji Group—fifteen islands and fifty reefs, viz., Tulanga island, Angea, Nambus Angea bank, Angasa island, Namulka, Morambo, Engrasso, Cambia, Komo, Mothe, Karoni, Oloma, Oneata, Avia, Lakemba, Bacon's—2, Reed's—3, Nean, Tubutted, Yeaki, Hatafouga, Vanderford, Verna Ballan, Susui, Manea, Sicombia, Avla, Olohu, Muago, Hanathea, Molucio, Ohembon, Nartomba, Zelangula, Chielia, Vataia, Namko, Oneholafrango, Onuminsio, Houlelavon, Oretena, Lavatala, Kenobid, Iac, Lomo Somo, Budd, North, Maury, Holmes, De Haven, Oranibi, Okid, Lortoai, Maola, Nanai, Angasa, Gora, Batika, Vanul Levu, Morna orna, Malee, Vakai, Maeona—2 islands, Direction—4 islands, Horse Shoe Reef, Ovalow island, Moro, Neniau, Passage, Ono, Kantavu.

Passed Midshipman's Group of Islands, ten in number.—G. Endua, Bteumna, Mallana, Benga, Nuanoka, Viti Levu, Flying Fish reef.

Midshipman's Group of Islands, four in number.—Maton island, Maloio.

Waldron island, Speiden, Palmer, Perry, Alden, Case, Johnson, Carr, Walker's, Emmons.

Knox island, Davis island, Baldwin's island, Totten's island.

Vouno island, Vier Valane, Waid Lalai, Ward, Biva, Agate, Sinclair, Fox island, Eld, Naviti, Nagetta, Matatha Valie, Otoasan island, Nanoga island, Nadora, Orana, Ya Asalana, Ya Asana, Ya Roin, Mimbora, Naloa, Vendola, Tavia, Muthauata, Kinsuna, Round island, Angrajas, Gera, Chicobia, Nugulou, Corabia, Maselou, Annan, Beoia, two islands, Endura islands, and 51 reefs in this Fiji group, Gardner's island, McKean's, Hull's, Sydney, Taber, Washington or New York island, Jarvis's, Enderby's, Bennie, Duke of York, Duke of Clarence, Bowditch, Swain's, Ellen's islands or group, Tracy's island seen, Depeyster's island discovered.

Kingsmill Group.—Drummond's island, Bishop or Sydenham's, Woodle's, Henderville's, Hull's, Simpson's, Knox, Charlotte, Matthews, Pitt's islands, two, Mulgrave, Arrowsmith's, Daniels, Peddars, Pescadores, Karsakoff, two islands.

Sandwich Islands.—Oahu, Kaui, Hawaii, Maui.

Columbia River—surveyed to the cascades and falls, one hundred and twenty miles.—Straits of Quan de Fuca, Puget Sound, Nasqually, New Dungeness, Classet Harbor; and all the harbors in that vicinity.

Examined territory of Oregon, &c.

San Francisco Sacramento.

Ladrones.—Wakes, Gusan, Assumption.

Madeira island.

Looloo islands and sea, Mangsee, Straits of Balaback, Balanquay, Rhio, Banca, Sunda, Casper, Bourbon's island, Hunter's, Barney, Favorles, Luis, McKennie's, Straits of Barandena, Vasquez island, Pylstaarts, Sunday.

Rio Negro, Cape Horn, Orange Harbor, &c.

Antarctic Continent.—*N. Y. Journal of Commerce.*

6. *Observations for Shooting Stars, April* 20–21, 1842.—During the nights of the 17th, 18th and 19th of April, 1842, the sky at this place was overcast, and observation for meteors was of course useless.

The night of 20–21st was after 11 P. M. quite clear, and observations for shooting stars were made from the summit of the Hospital, by Messrs. F. Bradley, A. B. Capwell, E. Y. Gould, G. Wood, and myself. One quarter of the heavens was assigned to a single observer. The fifth person took charge of the chronometer, and occasionally aided one of the others, generally the observer looking eastward, so that the whole number of meteors seen, may have been one tenth greater than would have been discerned by four persons only.

The watch commenced at 10*h.* 20*m.* P. M., April 20th, and continued till 4 A. M. of the 21st. During that period, shooting stars were observed, as reported in the following table:

		N.	E.	S.	W.		
10*h.* 20*m.*	to 11 P. M.	3	1	2	1	=	7
11	to 12 "	4	3	3	3	=	13
12	to 1 A. M.	5	6	4	5	=	20
1	to 2 "	10	5	5	2	=	22
2	to 3 "	8	8	5	13	=	34
3	to 4 "	15	15	12	13	=	55
		45	38	31	37		151

The moon, ten days old, interfered until 3 A. M. of the 21st, concealing probably half of the meteors which would, in case of her absence, have been visible. Morning dawned at 3*h.* 30*m.* A. M., and by 4*h.* daylight had become strong.

Arranged according to apparent magnitudes of the fixed stars, there were *greater than* 1st, 3; *equal to* 1st, 24; *equal to* 2d, 27; *equal to* 3d, and *less*, 97. Of the whole number, not one appeared to explode: about ten left trains; in the absence of the moon more trains would probably have been seen. Nothing remarkable was noticed regarding the times of flight, or the colors of the meteors.

The apparent paths were not as uniform in direction as are those of the meteors of August 10th. Nearly three fourths of them might be traced back to a region about *Corona Borealis*, but there seemed to be no very definite point of radiation. Of the remaining fourth, a few seemed to diverge from about *Spica Virginis;* and the rest moved in various directions.

The places of two of the largest meteors were noted as follows:

0*h.* 35*m.* 7*s.* A. M. 21st. A meteor equal to Jupiter, commencing in R. A. 250°, S. dec. 13°, and disappearing in R. A. 225°, S. dec. 23°. Time of flight, 0.33*s.*

1*h.* 48*m.* 28*s.* A. M. 21st. A meteor nearly equal to Mars, commencing about R. A. 35°, N. dec. 67°, and disappearing when brightest in R. A. 145°, N. dec. 60°. Time of flight, 3.0*s.*

A slight *aurora borealis* was visible during the night. At 10*h.* 20*m.* a wide faint streamer, at N. 25° W., reaching to an altitude of 12°. About this time there was an auroral bank, obscured by the haze, about 2° high, and sending forth several faint streamers. At 10*h.* 26*m.* scarce any auroral light. At 10*h.* 33*m.* several indistinct luminous spots, and obscure short streamers. At 11*h.* a faint auroral bank, 2° high, but no streamers. Scarcely any further traces of the aurora could be detected until 3 A. M. (21st,) when were seen sundry slight auroral spots, 10° or 15° E. of North and 1° or 2° high.

Observations at *Hudson, Ohio*, were made under direction of Prof. Loomis, at my request. The following results were published by him in the Ohio Observer, of May 5, 1842. "On the morning of the 19th I rose to observe, and it was perfectly cloudy. For the morning of the 20th, a watch of eight students was organized, but this time also the sky was overcast. For the morning of the 21st no regular watch was kept, but a company of students, who were riding all night in an open waggon, made such observations as they were able. About one o'clock, A. M. they began to observe, and continued about an hour, when so few were seen, that they did not pay their whole attention to it. After the moon set, which was at 3 A. M., they renewed their watch, though not uninterruptedly. From this time to morning most of the meteors were seen. They observed only the eastern half of the heavens, and saw in all about *twenty* meteors. The sky was remarkably clear all night. If the entire heavens had been observed, the number of meteors seen would probably have been somewhat less than twenty per hour. This number certainly cannot be considered very extraordinary."

From the foregoing observations, it may be concluded that there was no unusual exhibition of shooting stars at this place, or at Hudson, O., on the morning of April 21, 1842. It will be remarked, that the morning of the *twentieth* was the anniversary of the meteoric shower of April, 1803; but whether any uncommon display of shooting stars was visible on that morning, we had no opportunity to determine.

New Haven, Conn., May 17, 1842. E. C. Herrick.

7. *Botanical Necrology, &c.*—Besides the irreparable loss sustained in the death of the great De Candolle, we have to mourn the decease of several distinguished botanists during the past year, viz.

Mr. Lambert, senior Vice President of the Linnæan Society; author of a magnificent work on the Pines, and proprietor of a very large herbarium, comprising the plants of Ruiz and Pavon, of Pallas, and also of Pursh, who published his Flora under Mr. Lambert's liberal patronage.

Prof. David Don, late Curator of the Lambertian herbarium, Librarian of the Linnæan Society, and since the year 1836, Professor of Botany in King's College. This celebrated botanist, and estimable man, died on the 8th of December last, at the age of 41 years. Mr. Don's place as the botanical editor of the Magazine and Annals of Natural History, has been taken by Prof. Balfour, the successor of Sir Wm. Hooker, in the botanical chair at Glasgow.

M. Guillemin, one of the botanical editors of the Annales des Sciences Naturelles, *Aide-Naturaliste* in the National Museum at the

Jardin des Plantes, and curator of the herbarium of Baron Delessert. He died at Montpelier during the past winter, of aneurism of the aorta. The vacancy in the editorship of the Annales, is filled by M. Decaisne. The vacancy in the zoological editorship, as well as the hair of entomology in the National Museum, left by the decease of M. Audouin, is filled by Milne Edwards.

M. Carreno, the favorite pupil of the late Lagasca, and a botanist of great promise, recently died at Paris, at the early age of 23.

M. Vaucher, of Geneva, author of the *Histoire des Conferves d'eau douce, &c.*, published at the commencement of the present century, recently died at Geneva, just as his large work on the Phanerogamic plants of Europe, appeared from the press.

Dr. Vogel, of the University of Bonn, a botanist of the highest promise, is one of the victims of the ill-starred Niger expedition. Information had been received of his safe arrival among the survivors at Fernando Po; but the next account brought intelligence of his decease, which took place on the 17th of December last.

Amos Eaton, senior Professor in the Rensselaer Institute, died at Troy, N. Y., May 10th, in the 66th year of his age. The name of Prof. E. has long been associated with the unwearied and ardent cultivation of natural science. In developing the botany of our country, and the geology of the northern States, he was an early and very successful laborer. His life was eventful. In 1791, he was an apprenticed blacksmith; in 1799, he was graduated at Williams College, with much reputation for knowledge of mathematics and philosophy; soon after, he commenced the study of law, under Alexander Hamilton, in the city of New York, and in due time was admitted to the bar; leaving the practice of the law, he became a practical surveyor, and agent for the Livingston estates on the Hudson; after a period of great trial and affliction, he prosecuted the study of botany, chemistry and mineralogy to some extent in New Haven, Ct.; in 1817, and in the spring and summer of that year, delivered his first course of public lectures, to the students of Williams College, on mineralogy and botany. The patronage then received from the faculty of the College, and the high interest of a large body of the students, determined him to give courses of lectures on the natural sciences. This he did in many places. The remuneration was slight; but he was enabled to prepare for his future works, and to diffuse extensively the knowledge of these interesting subjects. In 1818, he was invited by De Witt Clinton, to deliver his public lectures at Albany, and the next winter, he lectured on chemistry and geology, before the members of the Legislature then in session. Gen. Stephen Van Rensselaer, the generous patron of merit, employed him in 1820, to make a geological survey of the country adjacent to

the great western Canal, and the result was published in 1824, in a report of 160 pages 8vo., addressed to his patron, with a profile section of the rock formations, from the Atlantic Ocean across the States of Massachusetts and New York, to Lake Erie. Prof. E. was also engaged in other more limited geological surveys, until by the munificence of Mr. Van Rensselaer, the school was established at Troy, and Mr. Eaton was solicited to be its senior Professor and director of its literary course in the year last mentioned. The Rensselaer School enabled Prof. Eaton to prosecute his favorite plan of teaching his classes, by making them experimenters and lecturers to each other. All amusements were excluded, by leading the students to take their exercise and relaxation, in the practical applications of botany, geology, and the use of instruments for mensuration, surveying, levelling, &c. Some hundreds from various States, have thus been educated under him.

While lecturing at Williams College, Prof. Eaton prepared and published, the *Genera of Plants of the Northern States*, the embryo of that "Manual of Botany," which first gave to students the botany of the various species of our plants, and which improved by repeated additions, became in the eighth edition, the "North American Botany." This work has widely spread the principles and applications of botany, being written in a popular manner, and containing full views of the science, as exhibited in the method of Linnæus.

His "Index to the Geology of the Northern States," was published in 1818, and the second edition in 1820. In 1824, he published his "Philosophical Instructor," based on *Webster's Elements of Natural Philosophy.* It is unnecessary to mention his other works upon natural history, or to refer to the various papers from his pen in this Journal. He was for years an active professor of chemistry, &c. in the Vermont Academy of Medicine, at Castleton. In geology, he published many facts of the highest consequence, and Mr. Lyell has just assented to the correctness of the doctrine advanced first by Prof. E., that our coal and anthracite belong to one geological formation. Although great modifications are making in our geology, the names given by Prof. E. to many rocks of New York, have been retained as very useful for reference. He died in peace. Benevolent and kind in his disposition, he warmly attached to himself his pupils and friends; and he will long be remembered, as an active and successful pioneer in the investigation of the natural history of his country. D.

New Publications.—In the moment of closing this number, we have received the second Bulletin of the National Institute at Washington, pp. 220, with plates—also, a volume of 582 pages, with nearly 300 wood cuts, by Thomas Ewbank, being a history of hydraulic and other machines, and of the Steam Engine.

THE

AMERICAN

JOURNAL OF SCIENCE, &c.

ART. I.—*Address before the Association of American Geologists and Naturalists, assembled at Boston, April 24, 1842; by Prof. B. Silliman.**

GENTLEMEN OF THE ASSOCIATION:—

DURING the past year, my labors have been, with few exceptions, confined to the study, the cabinet, and the laboratory; while their results, such as they are, have been presented in the American Journal of Science, in the lecture rooms of my own university, or in the halls of several of our towns and cities. Since our former meeting at Philadelphia, I have not enjoyed as many opportunities as in gone-by years, of making original geological explorations. In that time, I have been only two days in the field, but those were days of peculiar interest, because they afforded me an opportunity of comparing my own views, respecting a very remarkable region,† with those of one whose experience and knowledge confer peculiar value upon his opinions.

Still, I could have much preferred, that the present duty should have been assigned to some one of the able practical explorers now before us: geologists not of the cabinet, merely, but fresh from actual toil upon the broad field of nature; fresh from exploring tortuous river courses, intricate defiles, precipitous valleys, mazy caverns, deep mines, impending sea cliffs, lofty mountain tops, and alpine glaciers, with their cataracts, their avalanches,

* Delivered in the Swedenborgian Chapel, on Tuesday evening, April 25, before the Association and the public.

† The red sandstone and trap formation around New Haven.

and their eternal snows—for such scenes are familiar, in a greater or less degree, to some of those whom I have now the honor to address. In the absence of similar opportunities of recent date, permit me to rally a few of the impressions of our science existing in my own mind, and to occupy a portion of the passing evening in speaking to you—

Of the dignity and importance of geology; of its object, means, and ends; of its progress and present condition, especially in the United States; of its desiderata and difficulties; and of some of the powers or dynamics by which its results are produced.

OF THE DIGNITY AND IMPORTANCE OF GEOLOGY.

The planet on which we dwell is our birth-place—it is our cradle, and it will be our grave—the grave of our mortal bodies, but not of our immortal minds. In the present life, it is the scene of our busy action—but we aspire to a better life in a brighter world, where vicissitudes and death are unknown. These exalted hopes we build on our religious faith, founded on the intellectual and moral revelation which God has made to man. But our advancement in natural science is not dependent upon our faith. All the problems of physical science are *worked out* by laborious examination, and strict induction. If the toil is great, the reward is also rich. In this delightful exercise of our faculties, we attain high intellectual and moral advancement; we gratify our curiosity and regale our imaginations, by interesting discoveries, while we constantly improve our condition, and advance to the highest degrees of civilization and social improvement.

Geology, whether studied in the cabinet or in the field, is always replete with interest. Founded on the sure basis of observation, advancing year by year, in the development of new facts, it is, truly, a *noble science*, which is destined to advance to the end of time. In grandeur, geology is inferior only to astronomy; but it is superior to it in its inexhaustible stores of tangible facts, diversified in all the profusion of creative power, and rising to our view in the form of the most astonishing revelations. Astronomy is dependent upon one sense only, aided by telescopes, by the mathematics, and by geometry; its objects, innumerable indeed, are vast in magnitude, and placed at such inconceivable distances that the mind is overwhelmed in the contemplation;—

and when the machinery of the heavens is understood, our triumph in the amazing discovery is chastened by a profound consciousness of humiliation, in view of our own comparative insignificance.

Geology summons to its aid all our senses; its objects are every where around us—they are constantly before our eyes and beneath our feet; we cannot escape from them if we would—we see them—we feel and handle them. The telescope, whose field of vision is the starry sky, is comparatively useless in the fields of geology. We do, indeed, direct it to the snowy pinnacles, the inaccessible mountain cliffs, and the volcanic beacon lights; it is, however, only that we may judge of their bearing, their distances and elevation; but the telescope, while it penetrates the profound darkness of celestial space, and collects in a bright focus the scattered rays, that have wandered from distant worlds, is powerless, if directed towards the earth; for, excepting the occasional glare of volcanic fires, no light comes to us from the profound recesses of our planet.

MICROSCOPICAL RESEARCHES.

Geology has, however, derived powerful aid from the microscope, which, in astronomy, has not the smallest application. The microscope has revealed to us the intimate and concealed structure of fossil plants—of petrified trees, whose delicate vessels had been filled with mineral matter—siliceous, calcareous or metallic—or whose substance had been converted into coal; we discern the fibres and tissue of primeval forests converted into stone; their resins and gums stored away in the dark beds of coal, are now, as it were, created anew, like beings of yesterday, and thus we restore the vegetation of remote ages. The microscope has brought the most signal aid to comparative anatomy; by its assistance, thin sections of both fossil and modern teeth and bones are compared, and thus analogies and contrasts are established between the ancient and the recent races of animals. The earth is the grand mausoleum of the beings that have lived and died upon its surface, in its atmosphere, or in its waters.

The laws of carnivorous as well as of vegetable regimen, and the ordinary course of spontaneous decomposition do, indeed, resolve by far the greater number of living beings into food, or into new forms of animated existence—thus causing their ele-

ments to travel in ceaseless circles of organic revolution; but vast numbers of them, escaping from the general ruin, are entombed without being destroyed—their elements are not separated nor their members dissevered; their forms, filled in with and accurately copied by mineral matter, are encased in solid stone, or frequently in metals, and thus unfold to our view—in the firm rocks of our plains, hills, and mountains—a lucid record of their chronology, equally incapable of being falsified or misinterpreted.

Thus among the fossilized animals and plants, we discover forms both of colossal and minute dimensions; until the unassisted eye ceases to distinguish between the organized being, and the mineral matter by which it is enveloped. And here it might well have been supposed, that we had reached the ultimate limit of optical research; and little did our predecessors, or even ourselves, until very recently, imagine, that still another world lay concealed, in senseless mineral matter, and that it would in due time be fully disclosed to our inspection. Wonders on wonders had, indeed, been revealed in former years, by the microscope, among the infinitesimal tribes—our living contemporaries—that at this moment, in full activity, people the bodies of plants and animals, the waters, the atmosphere, and the wide earth. But these are only the successors of similar races now to a great extent extinct, for we are convinced by the evidence of our senses, that animalcules, often of inconceivable minuteness, were not less numerous or various, in earlier ages, than at present.

The microscope, in the hands of Ehrenberg of Berlin and of his pupils and followers, and of other students of microscopic analysis, (among whom Professor J. W. Bailey of West Point is the most distinguished in this country,) has not only passed in review the living infusorial animalculæ, but has penetrated the veil that concealed the fossilized races, whose existence had not been even suspected. We are now enabled to *see*, not vaguely, but in accurate forms and with appropriate organization, the thousands of millions of animalcules, which, encased in shields of flint, peopled, in the dimensions of a single cubic inch, the waters that deposited the polishing slate (rotten stone) of Bilin, and the sediment of peat bogs; the bog iron ores are not less replete with similar beings, clad in ferruginous envelopes, in coats of iron armor, like the knights of historical romance. Even the

hard agates and chalcedonies, the opals, the jaspers, and the chalk flints, bear ample testimony, by their included organic forms, that the time was, when they were not in existence, and these evanescent beings, the fossil animalculæ, enjoyed their day or hour of life, before these beautiful minerals were formed.

In the same manner, the vast beds of tertiary, of chalk, and many of the secondary limestones disclose, under the searching scrutiny of the microscope, a world of minute organic forms, that once lived in that earlier ocean by whose waves their elegant structures were first sustained, and then broken down and comminuted into an earthy calcareous powder, which, to the naked eye, appears almost impalpable. In similar circumstances, both in the cretaceous and tertiary strata of New Jersey and Virginia, (as observed by Professors Bailey and Rogers,) the microscope reveals to our eyes myriads of Foraminifera* or polythalamous shells—their divisions perfect, their delicate edges and processes in fine preservation, their porcelain varnish lustrous and beautiful, and still so inconceivably small, that thousands of them have been seen to run, in a few minutes, through a pin-hole in a piece of paper.†

The attention of geologists is now powerfully directed to the results of microscopic analysis, which will probably be carried back through the earlier aqueous rocks, and may not cease until we arrive within the domain of fire, nor perhaps even before we reach to rocks that have been in actual fusion, where, of course, we should expect that all traces of organization would be destroyed. Although we cannot assign a limit to these researches, we are certain that one must exist, since, it is obvious, that mineral matter must have been first in the order of the creation; for no organized beings could have existed, until earth, waters, and air were provided, as the scene of their action, and to afford them the elements of nutrition.

It appears from these instances, that geology takes a high rank among the physical sciences. Indeed, while to a great extent it involves a knowledge of them all, it repays the zealous explorer with a rich intellectual recompense, and affords to civili-

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* This Jour., Vol. XLI, p. 213. Prof. H. D. Rogers's final report on New Jersey. Prof. W. B. Rogers's report on geology of Virginia, 1841, pp. 38 to 42.

† This latter fact was observed by Mr. Lonsdale with respect to the chalk of England.

zed communities the most ample means of wealth and of unlimited improvement. Geology, although not carried to perfection, is truly a science; for—

"Its ascertained facts are numerous; they are correctly observed and reported; they are skillfully classed and arranged, and a sufficient number of general as well as particular conclusions, has been drawn from them, to furnish the basis of a most interesting science. Its boundaries are daily extending, and will be extended without limit by continued observations; its evidence will therefore constantly accumulate, and although its theoretical speculations may change, nothing can occur to subvert the grand conclusion that the earth has a regular structure, and that its materials have been arranged, under the operation of general laws of great energy and duration, the physical expression of omniscient intelligence and omnipotent sway, guided by benevolent design, which becomes more and more apparent and convincing with every new and successful research in geology."*

OF ITS OBJECT, MEANS, AND ENDS.

Geology discloses the structure of the earth, and the nature of the mineral masses of which it is composed—the order of their succession and arrangement—the chemical composition of the rocks—the distinct minerals and the remains of organized beings which they contain—the veins and beds of metals—the strata of coal, limestone, plaster of Paris, mineral salt, clay, sand, and other materials useful or indispensable to civilized society; and it investigates the proximate causes which have produced the various effects that we behold, and which still continuing to operate will, in all future time, go on to produce their appropriate results.

It might seem to a common observer, that, treading only upon the crust of the earth, we can know very little of the deep interior of a planet, whose diameter is eight thousand miles; and that therefore any attempt to ascertain its structure, must be equally presumptuous and vain. But the geologist finds much more ample sources of information than might at first appear.

"Every artificial excavation—every well and cellar—every cut for a fort, for a common road, a rail-way, or a canal—every stone-

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* The Author's Introduction to Mantell's Wonders of Geology. Am. edition.

quarry and gravel pit—every tunnel through a mountain, and every pit and gallery of a mine—every boring for coal, for salt, or salt water, and every artesian perforation—furnish means of perusing the interior structure. Still more, do the inland précipices and the rocky promontories and headlands that rise along the rivers, lakes, seas and oceans; the naked mountain sides, ribbed with jutting strata, that bound the defiles, gorges, and valleys; the ruins accumulated at the feet of lofty pinnacles and mountain barriers, and those that have been transported far and wide over the earth, present to us striking features of the interior structure of the planet.

"Most of all, do the inclined strata push up their hard edges in varied succession, and thus faithfully disclose the form and substance of the deep interior, as it exists—many, it may be hundreds of miles and leagues, beneath the observer's feet."

"Volcanic eruptions throw up into daylight, the foundations of the fathomless deep below, either in the form of ejected or of molten masses, flowing even in rivers of fluid and ignited rocks, which congeal again on the surface of the ground, either inflated like the scoriæ of furnaces or in solid forms; often retaining no visible impress of fire, and containing, occasionally, very perfect and beautiful minerals, produced by heat in the bosom of the volcano, or dislodged from still earlier beds from a more profound igneous abyss, and impelled along by the irresistible current which often ruptures the crust of the earth, and covers it with a fiery deluge."

"In addition to the products of actual volcanoes—the ignigenous rocks, the granites, the sienites, the porphyries, the serpentines, the soapstones, and the traps—crystallized or amorphously deposited from fusion—injected both in the earlier and in many of the more modern epochs, among other rocks, and cutting across the strata of almost all descriptions and ages, are thus assimilated to the lavas, the known products of internal heat. Thus they give authentic information of the unapproachable gulf of fire, from which they were projected."

"The internal waters that gush cool from the fountains on land or under the sea, or those jets that spout in boiling geysers, from the deep caverns, where their imprisoned vapors accumulate explosive force; all these bring to the surface the materials of the deep interior, and conspire with tornadoes of gas, bursting from

volcanoes and other vents, to reveal the deep secrets of the earth."*

From all these sources, we have derived a competent knowledge of the structure of the crust of the earth—of that portion with which we are immediately concerned. Every extension of geographical research, especially as prosecuted in modern times, by the English, the Russians, the French, and the Americans, whether in overland or in maritime expeditions—to the islands of the Indian, Southern, and Pacific oceans, or towards the opposite poles—conspires to confirm the conclusion that a grand uniformity and simplicity of design characterize the geological structure of all countries, however remote. There is the same order in the arrangement of the rocks—there are the same associations of strata and of minerals—the same fossils marking similar geological epochs; and therefore we infer that a uniform code of laws has been prescribed for the whole.

Coal, with its characteristic fossil vegetables, is found in Melville Island, far within the northern polar circle, and Captain Ross, in 78° of south latitude, has recently discovered a powerful volcano in great activity, amidst the eternal snows and glaciers of the southern pole, flashing vividly upon the frozen Antarctic sky, from a crater at the elevation of 12,500 feet—a truly polar Teneriffe.†

Thus it appears that the polar lands of both hemispheres are glowing with intense igneous action. Iceland is a vast classical region of volcanic fire; the antipodal polar zones are sustained, it may be, upon subterranean seas of melted rock, covered by mountains and glaciers of eternal ice and snow, through which the internal fires force, here and there, an opening, and thus reveal the secrets of the nether abyss.

OF ITS PROGRESS AND PRESENT CONDITION, ESPECIALLY IN THE UNITED STATES.

Within our present limits of time, it would be in vain that we attempt even a sketch of a general history of our science, and the effort would be quite superfluous, as the work has been admirably done to our hands, in the introduction to Mr. Lyell's Principles of Geology. I trust I shall therefore be excused for

* *Loc. cit.*

† London, Edinburgh, and Dublin Philos. Mag. for Feb. 1842.

speaking only of my own times and for yielding to the necessity of introducing some notices of my own personal history, as connected, however humbly, with the progress of this science in the United States.

Having been educated to the profession of law, I was induced by the late President Dwight of Yale College, to enter on a new career, and to endeavor to qualify myself for the departments of science, to which I have since been devoted, and of which I was then ignorant. Two or three years of preparation in this country and another year in Europe encouraged me to enter, in 1806, upon a fuller discharge of the duties which I had partially commenced before going abroad. Chemistry was then my leading object, and mineralogy and geology were only appendages. In the latter sciences, it was then almost in vain that we sought in this country for cabinets or instructors. The most common minerals were known to very few, and I accounted it a piece of rare good fortune, that an introduction to the late Dr. Adam Seybert of Philadelphia, then recently returned from the celebrated mineral school of Werner, at Freyberg in Germany, enabled me to spread before that gentleman (Dr. Seybert) the entire cabinet of Yale College, which, for the sake of having the specimens named by him, I packed in a small portable box, and carried with me to Philadelphia. We may now, with pride and pleasure, contrast these *angustæ res* of earlier days, with the ample cabinets which are at present found in our institutions as well as in the hands of private individuals.* Geology was at that period, (1804–5,) less known among us than mineralogy. Most of the rocks were without a name, except so far as they were quarried for economical purposes, and classification of the strata was quite unknown.

Passing over to England in the spring of 1805, and fixing my residence for six months in London, I found *there* no school, public or private, for geological instruction, and no association for the cultivation of the science, which was not even named in the English universities. To the deep ancient mines in the Peak of Derbyshire, in central England, I had already resorted, and to these explorations I added others in the still deeper mines of Cornwall, famous from high antiquity for their tin, and in more modern times for their copper, both obtained at profound depths,

* That of Yale College is particularly large and fine.

and in some instances in galleries carried out beneath the bottom of the sea, where the chafing of the pebbles could be heard over the heads of the miners as they were pursuing their work. Although England was then without accessible means of scientific instruction in geology, and even mineralogy was far from making a considerable figure, many causes were in operation, to prepare the way for the signal development of scientific geology which soon after began to be made. Mining had been carried on for ages in Great Britain; her mines were numerous and deep, and very various in their productions, both in profitable and curious minerals; in this natural school of mines, many mining engineers and practical geologists were forming in various parts of the kingdom.—Among these, William Smith* was laying the foundations of British scientific geology, by examining and comparing, quietly and almost in solitude, the secondary strata of England, especially as to their organic remains, which he found to hold a constant connexion with their order of deposition; and to him, more than to any other man either in Britain or elsewhere, is due the honor of demonstrating that particular fossils are characteristic of particular strata—the types by which they may be recognized, in situations the most remote. Mr. Smith has been therefore justly called the father of English geology, and he lived to see the splendor of its present bright meridian sun. His geological map and sections of England were founded upon his own laborious and long continued exertions, unaided by any public body or scientific association.

GEOLOGICAL SOCIETY.

But private individuals were no longer compelled to labor alone. In 1807, that noble association, the Geological Society of London was founded, and organized in 1811, in which year its first volume of Transactions appeared. Immediately, voices of grat-

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* Mr. William Smith, of Scarborough, England, was born in 1769 at Churchill, on the oolite formation in the county of Oxford. His taste for geology was early formed, by collecting terebratulæ from the oolitic rocks in the fields of his native village, which he used as a substitute for marbles. He had often expressed a wish to be buried in this formation, on which he was born and educated, and the history of which he had so much elucidated. He died in August, 1839, on his way to the meeting of the British Association at Birmingham, aged 71, and was interred in the churchyard of the beautiful Norman church of St Peter, in Northampton, which stands on the oolite formation.—*Dr. Buckland's Address*, 1840: *quoted in this Journal*, Vol. XL, p. 219.

ulation from every quarter hailed and cheered onward the new-born institution, which like Hercules, was vigorous even in its infancy, and in its advancing maturity has already performed numerous and most important labors. Its untiring activity, its concentrated scientific talent and zeal, its munificent endowments, and its splendid success, have for more than a third of a century, given it universal and richly deserved celebrity. We cannot on the present occasion, even mention the names of its most conspicuous members, and they stand in no need of our commemoration, for their worthy deeds are fully recorded and amply illustrated in the now numerous quartos of the Society's Transactions.

GEOLOGY IN SCOTLAND.

Returning to my personal narrative in Britain, I beg leave to remark, that having eagerly seized upon every opportunity of making observations in geology, I had learned in the mines and mining districts, *how* and *what* to observe; and in passing through the length and breadth of England in four different directions, I was almost never without some instructive field before me. Glancing at the coal regions of the middle and northern counties, at the chalk downs and escarpments of Wiltshire and the Isle of Wight, at the quarries and cliffs of limestone and oolite of Bristol and Bath, at the sandstone quarries of Liverpool, the granite tors and sea-beaten precipices of Cornwall and the Lands End, the gravel pits and clays of the London basin, and the lime-kilns of Gravesend,—none of these scenes were without instruction to one whose curiosity was awakened and whose youthful enthusiasm was kindled by vivid perceptions of the beauty and grandeur of geology. Nor was a view of the boundless green meadows of Holland—a vast alluvial with immense beds of peat, redeemed from an ocean, whose waves were held in sullen repulse by artificial dykes and natural mounds of sand, thrown up by the billows themselves, along the seaward line of coast;—nor were the interminable sandy plains of Dutch Brabant, nor the rural luxuriance of the Austrian Netherlands, without geological utility, since no scene, however tame to a common eye, is without instruction to a geologist.

A rapid transit, late in November, 1805, through the fens of Cambridgeshire and the picturesque wolds of Yorkshire, brought me across the Tweed to Scotland, to view the bleak and naked hills of Berwickshire, the fertile fields of Mid Lothian, and the

castellated trap rocks of Edinburgh, rising in black frowning peaks and ridges, in the very bosom of that beautiful city. Arriving in Edinburgh at midnight, the morning light disclosed to my view the noble outlines of a grand and beautiful country, and I was in an instant transported to my own quiet city of New Haven, the hills near to which, (of whose geological character I was far from feeling assured, even up to the hour of my leaving them behind,) I now felt convinced were true trappean ridges and peaks, adorned, like Salisbury Craig, Arthur's Seat, and the Castle Rock of Edinburgh, with grand colonnades and castellated summits.

In Edinburgh, that focus of talent and knowledge, chemistry was then cultivated with great zeal and success, both in the university and in private courses; it presented ample stores of science, with rich and satisfactory proofs by experiment. All the departments of physical science were indeed well sustained there, but our limits of time will allow us to speak on the present occasion only of geology. In that science, Edinburgh was then far in advance of London. It shone as a brilliant boreal aurora, whose coruscations mounting to the zenith, were observed even in the distant south, soon to be illuminated in its turn by an increasing and steady effulgence. To produce this state of things, various causes had concurred. The region around Edinburgh is rich in geological facts; that for many miles around London was then supposed (although erroneously) to possess very little geological interest; for its tertiary treasures had been little explored, and they, as well as the similar deposits in other countries, had as yet received no distinct classification in geology. Prof. Jameson having recently returned from the school of Werner, fully instructed in the doctrines of his illustrious teacher, was ardently engaged to maintain them, and his eloquent and acute friend, the late Dr. John Murray, was a powerful auxiliary in the same cause; both of these philosophers strenuously maintaining the ascendancy of the aqueous over the igneous agencies, in the geological phenomena of our planet.

On the other hand, the disciples and friends of Dr. Hutton* were not less active. He died in 1797, and his mantle fell upon

* Dr. James Hutton, born 1726, was graduated as M. D. at Leyden in 1749, settled in Edinburgh in 1768. He published various works on science, and in 1795 his Theory of the Earth, in two volumes octavo, which was explained with additional illustrations by his friend, Prof. Playfair.

Sir James Hall, who, with Prof. Playfair and Prof. Thomas Hope, maintained with signal ability, the igneous theory of Hutton. It did not become one who was still a youth and a novice, to enter the arena of the geological tournament where such powerful champions waged war; but it was very interesting to view the combat, well sustained as it was on both sides, and protracted, without a decisive issue, into a drawn battle.

Scotland and its isles present a great geological cabinet, where especially the phenomena attributed by Vulcanists to igneous action, are exceedingly remarkable. They had been examined with a severe and discriminating scrutiny by Dr. Hutton and his followers; Playfair had reviewed them in his splendid illustrations of the Huttonian theory, and had followed them into the few districts of England, Derbyshire, Cornwall, &c. where similar phenomena had then been observed. Dr. Murray had also published a lucid comparative view of the Huttonian and Wernerian theories. Wales, now made classical ground, both for the ancient fossiliferous and for the igneous rocks, by the memorable researches of Murchison and Sedgwick, was then regarded merely as a country of quarries, whose mountains were indeed rich in slate and coal, but presented, as was supposed, no particular geological interest.

The conflicts of the rival schools of Edinburgh—the Neptunists and the Vulcanists, the Wernerians and the Huttonians, were sustained with great zeal, energy, talent, and science; they were indeed marked *too decidedly* by a partisan spirit, but this very spirit excited untiring activity in discovering, arranging, and criticising the facts of geology. It was a transition period between the epoch of geological hypotheses and dreams, which had passed by, and the era of strict philosophical induction, in which the geologists of the present day are trained. No state of things could, however, have been better adapted to excite the enthusiasm and fix the taste of a youthful mind, just beginning to feel the vast power of geological truth, and to relish with intense interest both its researches and its speculations.

I was therefore a diligent and delighted listener to the discussions of both schools. Still the igneous philosophers appeared to me to assume more than had been proved regarding internal heat. In imagination we were plunged into a fiery Phlegethon, and I was glad to find relief in the cold bath of the Wernerian ocean,

where my predilections inclined me to linger. But the preference for the aqueous over the igneous agencies gradually yielded to the force of accumulating evidence, until both views became combined in my mind into one harmonious whole.

EARLY CONDITION OF GEOLOGY IN THE UNITED STATES.

Early after the establishment of the European colonies in North America, researches were undertaken for valuable minerals, chiefly the ores of metals, and many remains of ancient diggings are found, which in general contributed as little to the advantage of the adventurers as of science. The records of our learned societies, however, present a considerable number of papers, both of an earlier and later date, containing notices of facts in mineralogy and geology, and sometimes scientific speculations. In looking over the volumes of the Philosophical Society of Philadelphia, we find, that

Belknap wrote upon the White Mountains, 1784. Hutchins on the rock and cascade of the Youhigony, 1786. Franklin proposed a theory of the earth, 1793. Latrobe described freestone quarries, 1807. Maclure gave a geological map in 1809.* Gilmer gave a theory of the Natural Bridge in Virginia, 1816. Steinhauer elaborately described and figured several of our coal plants, 1818. Jefferson described the megalonyx, mastodon, &c., 1818. Drake the valley of the Ohio, 1817. Gibson trap rocks in Pennsylvania, 1820. James the trap and sandstone of the west, 1821. Hayes described mastodon bones, 1834. Harlan the fossil bones of the tertiary, 1834.† W. B. and H. D. Rogers the tertiary of Virginia, 1839. Clemson and Taylor the coal of Cuba, 1839. Lea the oolitic fossils of North America, &c., 1840.

In the Transactions of the Boston Academy, we find—

Belknap on vitriol and sulphur in New Hampshire, 1780. Gannett on a yellow mineral pigment, 1782. Webster on oil stone, 1782. Lincoln on the geology of York river in Virginia, 1783. Gannett and Jones on the West River Mountain, 1783. Williams on earthquakes, 1785. Baylies on Gay Head, Martha's Vineyard, 1786. Hitchcock on frogs found in the earth, 1789. Dewitt on the minerals of New York, 1799. Fothergill on ice islands, 1809. Godon on the minerals near Boston, 1807 and 1808.

* Revised in 1817.

† And bones of the Ichthyosaurus found in Missouri.

Cleaveland on fossil shells, 1808. J. F. and S. L. Dana on the mineralogy and geology of Boston and its vicinity, 1818. Jackson and Alger on the mineralogy and geology of Nova Scotia, 1831.

There are numerous geological notices in our medical journals, especially in the Medical Repository of Mitchill and Miller, of New York; in the Proceedings of the Geological Society of Pennsylvania; in the Physical Researches of Dr. Harlan; the Contributions of Mr. Lea; the works of Vanuxem and Morton, especially in the distinct volume of the latter upon the chalk formation; and doubtless in many other works which we cannot recollect or need not enumerate.

Resuming my personal narrative, I returned to America in June, 1806, and being anxious to compare the region of New Haven with that of Edinburgh, I eagerly reviewed my own immediate district. It is a fine region of trap rocks, with sandstones, through which the traps rise in bold ridges and peaks, while in close proximity, are immense ranges of primary rocks, amorphous and slaty. Of this region, on an area described by a radius of five or six miles, I made a geological survey and a report,* the imperfections of which may claim the more indulgence, as it was, I believe, the earliest attempt, but one, of the kind in the United States.† In the year 1799, a very brief mention is made by Thomas P. Smith, in the Transactions of the Philosophical Society of Philadelphia, (old series, Vol. 4, p. 445,) of some columns of basalt in Pennsylvania, and in the year following my report in the same records. M. Godon, a French geologist then in this country, presented some minutes towards a geological map of a part of Delaware, which I believe was never finished.

In 1807, the year after my return, Mr. William Maclure passed several days in examining the geology of the immediate vicinity of New Haven, and I enjoyed the advantage of being with him on that occasion. He was then engaged in that extensive tour of observation which eventually covered the United States, Canada, and the West Indies. Of these labors he communicated an account to the Philosophical Society of Philadelphia in 1809,

* To the Connecticut Academy of Arts and Sciences.

† At the meeting of the Association in Boston, Dr. Dana read the title of what was probably the first geological report made on American geology, viz.—"Beytrage zur mineralogepfer Keintre und des Cëstlicheu theils von Nord America und sum Gebürsge von D. Johamre David Schöpf."

and a revised and extended account in 1817, which was published in their Transactions for 1818, with a colored geological map.

Mr. Maclure had personally examined almost every remarkable geological field in Europe, and was therefore well qualified, according to the standard of knowledge of that day, for the Herculean labor which he undertook. His geology of the United States was also published separately at his own expense, in a small unpretending volume, of which the motto might well have been, *multum in parvo.* It was however imperfect, especially in the more recent formations, the dividing lines having then been but very imperfectly drawn, between the alluvial and the tertiary, between the tertiary and the newer secondary, and even between the different members of the latter; and, moreover, the study of fossils and of fossil anatomy, having since that period made great advances, it is not surprising that younger geologists, in surveying in detail parts of Mr. Maclure's domain, should have found some things to correct and much to supply.

Still, William Maclure, (who was the William Smith of this country,) performed an immense service for geology, and this, with his munificent endowment of the Academy of Natural Sciences of Philadelphia—in its library, its cabinet, and its noble hall—and his liberal donations in many other ways, for the promotion of useful knowledge, for the education and elevation of the ignorant and the oppressed in various places and countries, richly entitle him to the gratitude of mankind, and to the warm eulogium pronounced upon him by Dr. Morton, the president of this Association.

William Maclure passed the latter years of his life in the city of Mexico, to which he was attracted by its fine climate, and there he died about two years ago, at the age of very nearly fourscore. Mr. Maclure brought large collections of specimens of minerals into the United States, but the earlier cabinets formed in this country, or imported from abroad, had more reference to mineralogy than to geology. They however excited attention, promoted inquiry and observation, and gradually attracted geological collections around them.

Such were the cabinets of Harvard University, presented by Dr. Lettsom and the French republic, and since splendidly enlarged by Professor Webster; the collection at Bowdoin College, Maine, by Prof. Cleaveland; that of Dr. Samuel L. Mitchill, and

of Dr. Hosack, and more especially of Dr. A. Bruce, of New York; that of the Philosophical Society, and of Dr. Seybert, in Philadelphia; that of Prof. Frederick Hall, recently presented by him to Dartmouth College, with a foundation for a professorship of mineralogy and geology; that of B. D. Perkins and of Col. Gibbs, the latter a splendid collection, since purchased, as that of B. D. Perkins had been before, by Yale College. Col. Gibbs was a zealous promoter of geology as well as of mineralogy. He freely gave time, influence, and money for these objects; and it was my fortune during the summers of 1807 and 1808, to explore with him the beautiful fields of Rhode Island. He was fresh from the French school of mines of Paris, and fully imbued with the science of that fine national institution.

It will be observed, that the period of which we are speaking was contemporary with that of the formation of the Geological Society of London. The impulse given in Europe had reached America, and now geology began to be taught among the physical classics of our country, in most of the higher institutions of learning.

Individuals, either alone or associated, undertook geological explorations. Among the earlier were those of Prof. Cleaveland in Maine, and his fine work on mineralogy, with an appendix on geology, produced a powerful effect on the public mind. The Messrs. Dana, brothers, in 1818 made a detailed and valuable report on the mineralogy and geology of the vicinity of Boston, as M. Godon had done less extensively in 1807 and 1808. Prof. Denison Olmsted, under state authority, explored with signal success the mountains of North Carolina. Prof. F. Hall made early and valuable explorations in Vermont and the adjacent states. In New York, Dr. A. Bruce, in 1809, had instituted a journal of mineralogy and geology, and the connected arts, but the decline of his health suspended the work after the completion of the first volume, and the American Journal of Science and Arts, on a more extended plan, succeeded in 1818 to the journal of Dr. Bruce. Mr. Robert Gilmor, of Baltimore, formed a beautiful cabinet of the rarer minerals and gems, in which taste, science, and wealth, conspire to enrich the collection.

Dr. H. H. Hayden published an interesting volume on diluvial remains and diluvial action; and Prof. Amos Eaton, under the patronage and at the expense of the late Gen. Van. Rensselaer of

Albany, made an elaborate survey of the geology of the country on the Erie canal. Prof. Hitchcock described the valley of the Connecticut; Prof. Dewey the western part of Massachusetts, the memoirs of both being illustrated by geological maps and sections. Mr. James Pierce described parts of New Jersey, the Cattskill mountains, Maine and Florida, &c. &c. The Academy of Natural Sciences in Philadelphia, the New York Lyceum of Natural History, and the Albany Institute, formed valuable collections and published important memoirs; the American Journal of Science and the Boston Journal of Philosophy by Dr. Webster, recorded many of the geological observations of the day, either in the form of original papers or copied from the archives or publications of learned societies. In the American Journal of Science alone there are about four hundred memoirs and communications on geology and mineralogy; most of them are original papers and by far the greater part are accounts of American researches made in illustration of the mineralogy and geology of the United States, Canada and Nova Scotia. In Canada many British officers were very active and successful explorers in geology. Dr. Charles T. Jackson and Mr. Francis Alger of Boston, in 1828 and 1829, published in the American Journal of Science a full and able account of the mineralogy and geology of Nova Scotia, with a map and pictorial illustrations. In 1831, this memoir much enlarged and improved by a second visit to Nova Scotia appeared in the Transactions of the American Academy at Boston.

In the above enumeration, we have not included hundreds of miscellaneous notices, besides numerous communications published in the journals and transactions of our academies, and in various journals more or less scientific. Nor do we include many reports on geology and mineralogy made to the general government by their authorized scientific travellers, such as the journals of Lewis and Clark, Mr. Schoolcraft and Major Long; nor geological works relating to foreign countries although written here —as, for instance, the excellent account of the Azores or Western Islands, by Prof. J. W. Webster of Harvard University, who was one of our early and active geological explorers.

It is sufficiently apparent, that since the commencement of this century, and particularly within the last twenty-five or thirty years, geology has become in this country a favorite pursuit, and

that now its dominion although not yet perfected is fully established.

In proof of this position, however, it is not possible to give any thing more than an outline of our earlier efforts for the promotion of geology, and we shall have little time to glance at the agency of individuals in the field within the later years, in which geology has flourished with vigor. During the last fifteen or twenty years, many of the local governments of the individual states have caused to be instituted geological surveys of their respective territories—all of them appropriating public money, and many of them with laudable liberality, to the great object in view.

Geological surveys have been ordered and are now in progress or are already accomplished in more than three fourths, and if we include *reconnaissances*, in four fifths of our states and territories. We trust that with the return of a more prosperous state of affairs, the rest will follow. The general government has caused geological *reconnaissances* to be made in the territories which are still unappropriated, as state domains, and the exploring naval expedition, charged with the collection of specimens in geology and mineralogy, as well as in other departments of natural history, has already sent to the city of Washington a valuable harvest of these objects, to be deposited in the museum of the National Institute. State collections, illustrating the geology and mineralogy, and in some instances the zoology and botany of their respective territories, are also formed and forming in the different local capitals. Whenever the general government shall perform its duty, by carrying into effect the Smithsonian bequest, (thus imitating the promptness and fidelity exhibited in Boston in a case quite parallel—that of the Lowell fund,) then we may hope to have established at Washington in the manner of the school of mines at Paris, a grand national collection, which shall present in a connected and yet independent view, a faithful representation of the geology of our continent. Our neighbors in Nova Scotia, New Brunswick and Canada, have been for some years and still are actively engaged in exploring those important countries, in some parts of which are found great treasures of coal, grit-sandstone,* iron ore and plaster of Paris.

* Grindstones of excellent quality.

Lyceums.—Voluntary associations have been formed in great numbers in the United States, and are rapidly increasing, in which citizens and especially young people meet for instruction, chiefly by lectures; they form museums devoted to the collection of interesting objects, chiefly in natural history, and geology is a favorite subject of attention.

Geology is not confined to the learned. Popular lectures upon this science are now demanded in many of our cities, towns and villages, and with the aid of diagrams and specimens, the subject is rendered both intelligible and instructive to large and attentive audiences.

So highly and so justly is geological science appreciated among us, that a new order of professional talent is now called into action. Individuals, interested in exploring or in working useful minerals, no longer depend upon the decisions of the credulous, the ignorant, the superstitious, or the crafty; they invoke the aid of geologists conversant alike with theory and practice, and their opinions are usually regarded as final in questions of this nature, often involving heavy and it may be ruinous expenditures. The negative, which the geologist is often able to pronounce with perfect confidence in regard to a proposed mineral enterprise, is frequently of the most momentous interest to the parties, and may save them from destruction; while the affirmative will be presented with guarded caution by every geologist who regards his duty or his honor.

RECENT STATE OF GEOLOGY IN THE UNITED STATES, WITH SOME PRACTICAL RESULTS.

The results obtained in the United States for scientific geology have been highly satisfactory. For their details we must refer to the various reports of the state geologists, of which even a summary would occupy more time than we have at our command; and it is the less necessary as Prof. Hitchcock in his excellent address pronounced last year before this Association at Philadelphia, presented a lucid synopsis of American geology. On reviewing that abstract, I perceive very little to add.

Frequent notices, abstracts and reviews of the reports of the state geologists, often furnished by correspondents, have been published from year to year in the American Journal of Science, and the editors have had only to regret their inability, on account

of the number and frequency of the reports, to notice them all; especially as it was an agreeable duty to remark upon such valuable labors, where there was so much to commend and so little that merited criticism.

Foreign geologists may not be aware, that frequent reports, usually annual, on the geology of those states that are under survey, are either prescribed by their respective legislatures, or are deemed necessary by the geologists, to sustain the popular confidence and public spirit until a long continued labor, perhaps of several years, shall have been consummated; otherwise, there might be danger that the necessary annual appropriations of money would be withheld, and that thus an important enterprise might be defeated; this danger has been encountered in several cases, and has been realized, we trust only temporarily, in more than one.

We confide however in the intelligence and patriotism of our citizens ultimately to carry out these great undertakings, even in those states whose resources are the most embarrassed; and we have already expressed our confidence, that sooner or later every state and territory will be faithful to itself, in exploring its own resources by geological surveys, under public authority.

We can readily believe, that it might have been more agreeable to the state geologists to hold back their annual reports, until their entire labor should have been accomplished; for, a mature view of the whole ground might, very possibly, modify early and partial conclusions. For these ultimate results, we must patiently wait until the final reports in the different states are made. That of Prof. Hitchcock on the geology of Massachusetts, is already before the public in a third edition, revised and enlarged by the author, under the authority of the state, and the last edition is in two large quartos, expensively illustrated by numerous plates and figures. Distinct reports have also been made in the state of Massachusetts on all the departments of natural history.

It was stated last year by Prof. Hitchcock, that the final report on New Jersey, by Prof. H. D. Rogers, with a geological map and sections of the state, was published in 1840. In the same year Dr. Jackson's final report on Rhode Island appeared, including agriculture, with a geological map and sections.

Prof. Charles U. Shepard in 1839, published a report upon the economical mineralogy of Connecticut, and his colleague, Dr.

Percival, having recently finished his report on the scientific geology of that state, it awaits only the necessary appropriation from the legislature to insure its publication.*

Mr. James C. Booth's report on the geology of Delaware, has appeared since our last meeting. The reports of Mr. Featherstonhaugh on Arkansaw, and of Dr. Locke and Mr. Owen on Iowa, were mentioned by Mr. Hitchcock last year. The report on Iowa, which included Wisconsin and the lead mineral region, was published without illustrations, and we understand that a republication by the government of the United States, with that important addition, is expected. The geological survey of both Pennsylvania and New York being finished, we may expect an elaborate report from each of those great states; and from New York, an account also of all the other departments of natural history. Mr. Vanuxem several years ago made a report on South Carolina, through the public prints. The only states and territories therefore in which, or regarding which, there has been no decisive movement in relation to geological surveys, are Alabama, Mississippi, Florida, Illinois, and Vermont; in the latter state, however, the survey was defeated by only two votes, and we may therefore expect a speedy revival of the enterprise.

In Louisiana, a geological *reconnaissance* has been recently made by Prof. Carpenter, under the authority of the legislature, and among those states in which only this step (that of a *reconnaissance*) has been taken, should be mentioned Kentucky and Missouri.

COMPARISON WITH EUROPEAN GEOLOGY.

In comparing our geology with that of Europe, we find the scientific table of geological formations regularly filled, with the following exceptions.

Within the United States proper, there are no volcanoes, either dormant or active. The numerous volcanic vents on the western side of both North and South America and the contiguous islands, and those in California, Mexico, Central America, and the West Indies, relieve the eastern or Atlantic sides from the necessity of providing such safety valves for the internal fire, which finds a ready exit along the coasts of the Pacific and among the West

* This appropriation has been since made, and the work is now (July, 1842) in the press.

India islands. As speculative geologists, we might, indeed, be excused for coveting a few volcanoes within our own territories, where we might occasionally observe the intensity of igneous action; but however delightful they might be to the lovers of geological science and to the devotees of the sublime and beautiful, our sober practical population would not willingly barter their quiet and security for the terrific sublimity of earthquakes and volcanic eruptions.

In the earlier records of fire our country abounds, and in no part of the world can the phenomena of igneous rocks be studied with more advantage than in New England, in parts of New York, and of many other states, especially those through whose territories run certain longitudinal divisions of the great Appalachian chain.

With respect to aqueous or stratified rocks, we are deficient only in those strata that lie below the chalk and above the new or saliferous red sandstone. The equivalent of the chalk we have indeed in a vast extent, with the appropriate fossils lying in beds of clay, ferruginous sand, marl, &c.; but we have not yet discovered the proper mineral chalk itself. Beneath the chalk, we miss the oolite, the Wealden, and the lias, with their astonishing reptilian remains. Oolite has indeed been announced, on high authority, as existing in the State of New York, and in due time we shall be made acquainted with the proofs from included fossils and from relative position; for, without these, we can hardly be sure that strata, although they may have the oolitic structure, do really belong to the true oolite which makes so great a figure in England, and in certain parts of the European continent. In some cases, as in that of the Jura limestone, formations are admitted by geologists into the oolitic group because the strata contain the fossils that are characteristic of oolite, although the rock is destitute of the oolitic structure, and as regards its merely mineral characters, would never be referred by the eye to that family. This statement, as we suppose, contains the entire list of our deficiencies, and it is by no means improbable, that it will yet be filled up, in the wide range of our territories and in those of our neighbors, in which many regions still remain to be thoroughly explored. As an example of the intercalation of deficient rocks or minerals, we may mention, that during the last year, mineral salt in regular and very thick strata

—fifty or sixty feet—has been discovered, *in situ*, near Abingdon in Virginia, along with gypsum shale, and probably sandstone. There are abundant salt fountains at the same place, and the mineral salt was discovered in boring for salt water.

This is an interesting feature, added to our geology. We had before vast numbers of salt springs, but no solid mineral salt short of the Rocky Mountains. There, in a mountain on the Salmon River, it was observed some years ago, by the Rev. Mr. Parker, a missionary, who reports it to be floored and roofed by sandstone. (This Jour. Vol. xli, p. 214.)

The tin ore, (oxide of tin,) reported last year, as discovered by Dr. Jackson in the White Mountains, has been found by him in increasing quantity, and small bars or ingots of the metal have been extracted by the discoverer. This is an important addition to our metallic resources; and the extraction of metallic zinc from blende (the sulphuret) by Dr. Jackson, from the ore found at Eaton, New Hampshire, agreeably to the practice now adopted in Germany, is a happy beginning upon an ore heretofore regarded as of little value, but existing in great quantities in the United States.

We forbear to dilate upon the simplicity and immensity of many of our geological formations—a vast country constructed upon one great model, with such unity of design and with such persistence in the plan, that particular formations are found associated and running longitudinally northerly and southerly, through the entire continent.

The best architectural materials, granites, traps, porphyries, sienites, serpentines, soapstones, limestones, primary slates, and slaty rocks of every geological age, sandstones and conglomerates, abound. The most useful minerals are found also in large quantity—ores of iron, copper and lead, gold and silver, the latter especially as it exists in argentiferous galenas. Above all, coal-fields of unequalled magnitude, thickness, extent, and richness, with clays, marls, and sands, and soils, of every variety, furnish to our population all the means of national wealth and individual prosperity. Over vast regions, there has been no serious disturbance of the strata; they have been gently lifted from the waves, often without a fracture, dislocation, or an intrusion of an igneous rock, for hundreds of miles. This geological quietude affords vast advantage in working our coal-fields, especially the trans-

Alleghany deposits, where the "*troubles*" of the European mines are, in a great measure, unknown. At the same time, the disturbed anthracite region of central Pennsylvania, contains in its fractured and folded mountains and strata, a lucid record of the operations of fire, both in its mechanical effects and in the debituminization of the coal, which, without any material difference in its geological relations compared with those of the bituminous coal into which it insensibly graduates as we proceed westward, has yielded up its bitumen by expulsion or decomposition, urged by invasions of heat from below.

The Silurian formation of Mr. Murchison, so well described by him as it exists in Wales, is developed on an amazing scale, and with strongly marked features, in western New York, and generally in the Western States, while the tertiary, which, in other countries, Mr. Lyell has illustrated with unequalled copiousness and discrimination, extends along the Atlantic border of the United States—in some places far into the interior—and appears besides in many isolated positions, covering an extent of area probably not equalled in any other part of the world.

Our tertiary and upper secondary have been successfully examined by Dr. Morton, Mr. Vanuxem, Mr. Conrad, Mr. Lea, Mr. Nicollet, and others; but this field is far from being exhausted.

It is worthy of remark, that the trifid tracks and impressions on the new red sandstone of the valley of the Connecticut, so zealously explored by Dr. James Dean of Greenfield, and both explored, and figured and described by Prof. Hitchcock, leave no reasonable doubt, that they are, at least in part, due to the feet of birds*—some of them of colossal dimensions. It is certainly possible, that among the impressions of this period, if not among those already observed, may be found some of the batracians or chirotheria of the strata of England and Germany. The doubts concerning the latter having been cleared up by the discovery of bones, by the aid of which Mr. Owen, the great comparative anatomist of London, has ventured to restore the form of batracian reptiles as large as a bull or an elephant, we may hope that a fortunate development of the bones of these ancient birds may

* Reptiles would seem more probable, but many of the tracks appear decidedly those of birds.

enable us, in like manner, to restore their skeletons—when, without doubt, they will be found to be appropriate companions of the gigantic frogs of their day—not more acceptable however, we may presume, in their regal sway, than were the storks of fabulous narrative, when appointed by Jupiter to reign over the frogs of that epoch of comparative pigmies. We want nothing but the fossilized bones of these primeval birds, to establish their existence ages before the earliest period heretofore assigned to them in the tertiary, or very recently in the Wealden, above the oolite and below the chalk, by Dr. Mantell.

The gigantic birds and frogs would be also in perfect keeping with the colossal reptiles, the Ichthyosauri, Plesiosauri, Megalosauri and Iguanodons of that middle reign, the fit successors of the great Saurian fishes below the coal, as they were, in their turn, successors or companions of the carnivorous cephalopods of the Silurian rocks.

DESIDERATA AND DIFFICULTIES.

In speaking of the desiderata of American geology, I have only to refer to the mention already made of the deficiencies in our geological table. If those members of the geological series, in which we are deficient, do really exist within our territories, (giving them their widest range to the Pacific Ocean,) or, if they exist even in any part of North America, it is most desirable that they should be discovered, for our boundaries in science are not limited by political divisions. There is much remaining yet to be done in this country, and in all countries, even those that have been most explored; and the number of well instructed geologists is now so considerable in all enlightened communities, that the great work will assuredly go forward with ceaseless effort and with increasing success, presenting rich additions to our knowledge and giving still greater precision and extension to our scientific views.

Geology has now survived most of its difficulties. To examine the structure of this earth is no longer regarded as a vain, idle, or presumptuous pursuit. Its economical utility is admitted by multitudes in our public counsels, who neither perceive nor appreciate its high intellectual and moral interest, while the polemical opposition is gradually yielding to the force of truth and to more reasonable modes of criticism and interpretation.

Astronomy demands space, geology time; the former has long been conceded, and the latter will not be long withheld.

It is already admitted by multitudes, that the chronology of the Scriptures is, in strictness, applied only to the history of our race, the sole moral beings whom God has placed in this world; while all that precedes man in the creation, is limited, in duration backwards, only by that beginning, whose date is known to no being but the infinite Creator, and which certainly precedes, by many ages, the creation of man; how long, it is neither important nor possible to determine; long enough however to admit of the arrangement, consolidation and elevation by natural laws, of the crust of the earth and of all its wonderful, mineral, and organic contents.

The records inscribed upon the volumes of the earth's solid strata, and often buried beneath the mountains, are more copious, more legible, and more authentic, than historical medals, than Arundelian marbles, than Egyptian hieroglyphics, or Persepolitan characters. They cannot be falsified, corrupted or suppressed, and will remain, while the earth shall endure, a visible, tangible history, written by the finger of God upon the work of his own hands. Only a small portion of these volumes has yet been perused, but enough has been deciphered to prove, that the work has immense antiquity, and was compiled in successive epochs, during a series of ages—the inscriptions being, *like those of the holy mount, on tables of stone.*

OF THE POWERS OR DYNAMICS BY WHICH ITS RESULTS ARE PRODUCED.

IGNEOUS CAUSES.

On this wide topic, our time will permit us to say but little. It embraces all physical and chemical laws, and includes the entire philosophy of geology.

As the phenomena of the planet, belonging to past ages and recorded in its structure, conspire with the events still occurring under our eyes, to prove that no portion of this earth is now in the condition in which it was originally formed, we seek in vain for a goal of departure, from which to date the series of geological events. As the only direct revelation which we possess concerning the origin of the earth, and of the universe of which it is a part, is silent as to the condition in which the materials were

brought into existence, we are at liberty, on this topic, to make any supposition not inconsistent with physical and chemical laws. If we admit then, that the elements of matter were created in their simple or uncombined condition, (a supposition which is in no degree improbable,) then it is obvious, that a mutual and energetic action would be the immediate result of their first contact; intense ignition and general combustion would follow, attended by fusion, volatilization, and all the concomitants of a powerful chemical conflict. The action would relent as the combinations proceeded, as incombustible compounds resulted from the union of the elements, and as radiation into space cooled the surface. Thus, an oxydized crust would be formed around the nucleus of the earth, and similar incombustible compounds would be produced by all the agents that excite combustion—chlorine, iodine, bromine, fluorine, and other similar elements, if such there be. Water would of course be formed from the union of its elements, and as it obtained access through the fissured crust to the still combustible interior of the planet, violent phenomena of combustion and explosive eruption would follow, until the combustibles to which the water obtained access had been thoroughly burned. The heat evolved by the energetic chemical action, whether induced by combustion or by any other mode of chemical action, might ignite, to a great depth, the combustible materials lying beneath the crust; *thermo* and *galvanic* electricity would propagate the ignition to a profound depth, and the power thus evolved as an effect, might, in its turn, operate as a cause, until the entire interior became ignited, softened, or even fused, more or less extensively.

Such agencies would, of course, be attended by various and powerful chemical effects; combinations and decompositions would result in the augmentation of heat, which again acting thermo-electrically, would tend to perpetuate and augment its own energy. Our recent experience proves, that heat may be long given out by the so called perpetual batteries, so that arrangements may be imagined among the elements or compound materials in the earth, by which a perpetual evolution of heat may be produced, and this again in its turn may excite a perpetual flow of electricity, and thus the ignition, at first produced in the crust of the earth by combustion, may be made perpetual by thermo- and galvano-electricity.

Should we admit that the agents of combustion, which have been supposed in this statement to act first upon the combustible elements at the surface, exist also in the profound interior, so as to produce combustion there; or to combine in any other manner, so as to evolve heat, then we are supplied with another igniting power in the interior, in addition to the thermo and voltaic electrical. Nor need we suppose either of these powers ever to become extinct. Electricity, excited as suggested above, may flow on, without limit of time, and occasionally with paroxysmal intensity; the combustible elements, which, by burning or by other similar chemical action, have lost their combustibility may, by the power of galvanic decomposition and the chemical agency of hydrogen, be evolved again and be thus restored to their original combustibility. In this manner, the elements of water may be combined by combustion to produce that fluid, and this may be decomposed anew, so as to evolve the elements again in pristine energy. So, potassium and sodium and the metallic bases of the earths may be evolved, and the chlorides, iodides, bromides, and fluorides, may be alternately decomposed and recomposed, and the more combustible elements brought into combustion by contact with water or with oxygen in a state of freedom or with chlorine, or other similar agents, may serve as matches or as kindlers to ignite those that are more tardy in burning, until the most energetic effects of combustion are added to those of electricity, and thus an eternal circle of causes is established—causes whose existence and operation are experimentally proved, since they are now always at our command, to produce on the surface of the earth exactly such effects as we have supposed it possible that they may produce in the interior of the planet.

As a thermo and galvano-electric power is a permanent principle in nature, ever active and ceaselessly regenerated, with its attendant decompositions and combustions, we can no longer hesitate to admit its agency as the great cause of the internal heat of our planet; nor is it improbable, that the solar orb and all the central suns of other worlds derive their perpetual radiance of heat and light from a similar cause, although that cause, like all other final causes in our philosophy, is inscrutible to our minds, and must be referred ultimately to the agency of the Creator, in immediate and energetic action.

May we not suppose, that we now understand why the heat of the earth regularly increases as we descend, one degree of Fahrenheit for every forty five or fifty feet of descent; eighty two to eighty three degrees of Fahrenheit having been recently obtained in a spouting fountain of an Artesian boring at Paris, sunk to the depth of more than eighteen hundred feet, or over one third of a mile; the heat of a hot summer's day is thus obtained, unaffected by the atmosphere above, even when at zero.

The conclusion to which this regular progressive increase of heat, supposing it to continue, conducts us, is obvious, and is familiar to geologists—boiling water at the depth of two miles, ignited rock at ten miles, melted rocks at one hundred. Who can say that it is really so, and who can say that it is not? Are we then walking upon a shell—a frozen crust? If this cannot be certainly affirmed, neither can it be positively denied; while the actual eruption of molten rock through the ruptured crust of the earth, many times in a year, from some of its hundreds of ignivomous mouths, demonstrates that rocks are indeed melted in amazing quantities and at profound depths in the interior; while innumerable thermal and boiling fountains in all parts of the world, prove the elevated temperature of the interior.

It is not necessary to suppose with Mr. Lyell, that there are internal igneous tides of extensive prevalence that by their afflux will melt down the crust of the earth; for, from the analogy of volcanoes, we may suppose that the interior of the earth, may be in general only in an ignited or softened or pasty condition—tenacious but not flowing liquid, like water or melted iron; except that occasional accumulations of heat in particular regions, arising from local thermo or galvanic or chemical action might, in those places, impart unusual fluidity; and joined with explosive power from steam and imprisoned gases, as well as from expansion, and (it may be admitted also from local igneous tides) the result would or might be a rupture of the crust, and an outbreak or overflow of lava—in a word, a volcano; the explosion occurring where the force was the greatest and the resistance the least.

Those who adopt the theory of nebular condensation, and suppose the earth to have been formed by accumulation of such expanded materials, evolving heat as they became solid, will find no difficulty in admitting also the agency of the causes that have

been suggested; for, as regards the reality and continued operation of the causes upon which our induction is erected, it is quite unimportant when or how the solid materials of the earth were formed; because, commencing however or whenever they might, they would be governed by the same chemical and physical laws as now.

AQUEOUS CAUSES.

If the internal heat of the earth, with its permanent and efficient causes, be admitted, we have solved the most difficult problems in geology; for, immensely the greater part of our planet is of igneous origin, and all that is due to water, if thrown like a covering evenly around the globe, would form but a very thin film—scarcely, in a section of a globe of four feet in diameter, forming a visible line. The power of water is to dissolve, to crystallize, to lacerate, to wear down, to transport and to deposit the materials in new situations.

In estimating the chemical effects of water, we must endow it with all the solvent power which heat, under enormous pressure under miles of ocean or of incumbent land, would give it; and then we must regard it not simply as water, but as a compound fluid composed of all that water, in such circumstances, can dissolve; when perhaps red hot, a condition which it may well attain, it might acquire new and remarkable energy—softening or dissolving materials which might otherwise be unaffected by it. These views would appear particularly important to any metamorphic theory of rocks, the changes of which it would seem more reasonable to attribute to a conjoined operation of fire and water than (as regards their crystallization) to impute them to fire alone.

Gentlemen, after having detained you so long, I am not disposed to occupy any more of your time by discussing any peculiar theories of the operation of water. Its effects, both mechanical and chemical, are extensive and manifest to all. In the Wernerian school, the solvent powers of water were exaggerated beyond all credibility; and at this day, no geologist would venture to suggest that the mountains and the entire crust of the earth have ever been dissolved in its waters. While in later times the operations of fire have been, on substantial proof, (as on theory alone they were formerly by Leibnitz,) prodigiously extended, those of water have not been cancelled, although they have been

greatly circumscribed, and restricted within the limits which science and sound reason prescribe. Happily, it is the less necessary for me, on the present occasion, to trace the effects of water, since they have been, along with the general powers of geology, so ably elucidated by our distinguished foreign guest,* in his learned, elegant, and instructive works. In regard to our scientific and social relations, we will not however view him as a foreigner, while we salute him as our associate and friend. For to him, more than to any other or all other writers on geology, we owe our recovery from the illusions of dreams and visions, regarding imaginary powers supposed formerly to exist, but to have become exhausted or greatly enfeebled or even extinct, in modern times. He has proved to us, that the powers of nature are the same now that they have ever been; that except the act of creation and the first outbreak of the new-born elements and energies, there was nothing in the geological laws of former ages different from the present; and that the causes now in operation, acting with greater or less intensity, are sufficient to produce the effects of earlier epochs.

These positions are sustained by an ample train of induction from facts, drawn from a wide range of geological history, as well as of laborious, exact, and acute personal observation, carried on through many countries and through a long series of years. We account it therefore a privilege to have made his personal acquaintance, and many of us have been favored with opportunities of witnessing his methods of illustrating, in public lectures, the science which he has so successfully cultivated. Our fine packet ships, and still more the winged Atlantic steamers, have so much diminished the difficulties and delays of the passage, that we may expect a more frequent renewal of the visits of enlightened and cultivated individuals from Europe.

In 1839, Dr. Daubeny took a rapid survey of our country, and after his return, favored us with an interesting summary of our geology. We believe that no gentlemen from the scientific faculties of the English universities had ever before examined the United States.

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* Charles Lyell, Esq., was in the United States from the first week in August, 1841, to July 16, 1842, and being present in the Association of American Geologists at Boston in the last week of April, 1842, took part in their debates. See abstract of their proceedings in the first number of this volume.

With the exception of Dr. Daubeny, the visit of Mr. Lyell is perhaps the first that we have received from a distinguished European geologist. To us, it is an important advantage to compare our views with his, and thus to be assured, by visible symbols, that we do indeed understand each other's language. The kind and respectful manner in which, in his public lectures, he has treated the labors of our geologists—the prominence which he has given to their observations, and the gratifying coincidence between his views and theirs in relation to our geology, afford us satisfactory proof that the geologists of the old and of the new world do indeed observe and think alike.

But, gentlemen, allow me to observe, that American geologists have important duties to discharge towards each other—duties of justice, honor, fidelity and delicacy. Cultivating a field of vast extent and surpassing richness, separated by distance from each other, and laboring often alone, we cannot always be early informed of our respective observations and discoveries. In accordance therefore with the best feelings, and with the strictest rules of geological courtesy, while we maintain with good temper and dignity our own personal claims, it will I trust be our pleasure to place in prominent relief, the claims of our fellow laborers, to do full justice to their observations and discoveries, and to find more satisfaction in the advancement of science by our common efforts, than in any partial or personal acquisition of fame. The harmony and unity of effort which have thus far been happily maintained among us, will thus be perpetuated; and our annual meetings, (always, we trust, to be in future honored by the attendance and coöperation of our foreign friends, actuated by, and received in, the same spirit,) will then be equally instructive and delightful; they will become both focal and radiant points of intellectual light and moral influence, to the honor of our country and the common benefit of mankind.

Gentlemen—pardon me, if in my honest zeal for our noble cause, I have presumed to speak as a Mentor; or, if in giving historical notices of the shooting of American geology, as an offset from the European stock, I have ventured also to speak of my own humble participation in this arduous enterprise. As an original witness, I hope I have not transgressed the proprieties of the occasion, while I have frankly and honestly told the things I

knew. Thirty five years ago, some eight or ten* individuals began to labor in this country in the great cause in which we are engaged. It has flourished beyond our most sanguine expectations, and we now behold around us, or we recognize in all our states, a numerous corps of well instructed, zealous and active geologists.

Upon this happy result, while I congratulate the Association, my emotions of pleasure are chastened by the recollection that among our attending members on the present occasion, I stand in this place almost the sole representative of the original corps of American geologists—one half of whom are gone to that land from whose bourne no traveller returns. MACLURE, MITCHILL, GIBBS, BRUCE, and SEYBERT are among the dead.

Gentlemen, let us not forget that *our* labors must also have an end; and when *we* too shall have reached our goal, may we be cheered onward by a well founded hope, that this tangible earth which we now see and explore, may be exchanged for the heaven of our faith and hope—that glorious world whose very atmosphere is moral purity and love, and whose cloudless firmament glows with the light of eternal truth.

ART. II.—*Reply to Dr. Hare's further Objections relating to Whirlwind Storms; With some Evidence of the Whirling Action of the Providence Tornado of August*, 1838; by W. C. REDFIELD.

IN my Reply to the objections and strictures of Dr. Hare,† I attempted to show that these could have no weight or efficacy in disproving the whirlwind character of violent storms and tornadoes, and that good evidence of whirlwind action in the tornado of New Brunswick was afforded by those very facts which he had set forth as disproving its rotation.

Having corrected the errors into which my opponent had fallen, I also referred to additional proofs of rotation which had been afforded by this tornado. This was deemed sufficient in replying

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* Maclure, Gibbs, Mitchill, Bruce, Cleaveland, Gilmer, Hayden, Hall, (Fred.), Silliman.

† This Journal, Vol. XLII, April, 1842.

to Dr. Hare, who had chosen to "enter the lists" as a disputant, in support of his own and Mr. Espy's notion of the centripetal course of the wind in storms; particularly as this New Brunswick case had from the first been greatly relied on by these two writers, as supporting their peculiar theories.

At the same time, however, I possessed in my field notes abundant evidence of the constant rotative action of other tornadoes; and diagrams illustrating some of the traces of these storms had long been prepared and cut in wood; but I saw no defect in the evidence of rotation already exhibited, that could render the publication of these necessary.

Among the tornadoes the traces of which I had thus prepared to illustrate, was that which passed near Providence in August, 1838, of which some account has been given by Dr. Hare;* and as the desire to obtain favor for his own electrical hypothesis may have induced him to appear as my opponent, I propose, on this occasion, to exhibit what I deem to be conclusive evidence of the whirling character of his Providence tornado.

But before proceeding with this evidence, it may be proper to take some notice of his rejoinder, which, under the title of "additional objections," appears in the last number of this Journal. [This Vol. p. 122.] The friends of strict scientific inquiry have probably been disappointed in this paper; for he seems here to have abandoned the main question at issue, even as staked upon his own allegations, and to have undertaken a *petite guerre* of criticisms, which have little if any relation to the evidence on which the issue depends.

Dr. Hare says he had "endeavored to point out various errors and inconsistencies in the theory of storms proposed by me, or in the reasoning and assumed scientific principles on which that theory had been advanced." Now it has never been my purpose to "propose" or "advance" a "theory of storms" founded on "reasoning and assumed scientific principles." This has, indeed, been attempted by others; with what success, is best known to attentive inquirers. Whereas, I have mainly endeavored to exhibit a matter-of-fact view of the actual phenomena of storms, so far as relates to their progress, the violent rotative winds which they exhibit, and their immediate effects on the barometer. That

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* This Journal, 1840, Vol. xxxviii, p. 73–77.

I should assume, therefore, the correction and refutation of all the several allegations and errors contained in his second attack, will hardly be expected. Perhaps the following comments may suffice.

Humble as are the claims on which my "meteorological reputation" rests, I do not perceive that it depends so much on the particular "course" which my opponent has taken, as he seems to imagine, (par. 41); nor that it is likely to be materially affected by his writings on meteorology. But should the fact prove otherwise, I will endeavor to bear it with becoming philosophy.

Referring to the approval of my views by men of science, he says: "It strikes me, however, that a fault now prevails which is the opposite of that which Bacon has been applauded for correcting. Instead of the extreme of entertaining plausible theories having no adequate foundation in observation or experiment, some men of science of the present time are prone to lend a favorable ear to any hypothesis, however in itself absurd, provided it be *associated with observations*." Now, as before stated, it is "*observations*" and their results which I have mainly endeavored to promulgate: and in relation to storms, if it has been attempted to associate "hypothesis," whether "absurd" or otherwise, "with observations," it would appear to have been by my opponents; and yet the seeming dislike to "observations" may be somewhat unfavorable to this construction.—That my "Reply" was properly "so called," may be inferred from the evasive "course," as well as title of his rejoinder; and it appears likewise from the tone and character of the succeeding paragraphs as well as from the closing sentences of that under notice, where "reliable facts and observations,"—"established character of storms"—and "the whole modern meteorological school" are quoted in a form of words and connexion which I did not use.

It appears to be difficult for Dr. Hare to give accurate quotations, unless in the cases in which he ventures to give a reference. Thus, in par. 43, he succeeds in adducing more correctly than in his previous quotations, my remark that "the grand error into which the whole school of meteorologists appear to have fallen, consists in ascribing to heat and rarefaction the origin and support of the great atmospheric currents," &c. This is a question of atmospheric dynamics which I believe has not been sufficiently examined by any writer. The remark quoted was made incidentally, on the occasion of Mr. Espy's first attempt to discredit

certain facts or results which I had stated;* and if the pretended accusation and "denunciation" (!) of the meteorologists, which is now charged upon me, can be made to cover Dr. Hare's seeming discomfiture, perhaps I need not complain. By the ill chosen phrase "whole school," was simply meant, all meteorologists to whose writings I had obtained access. It was an inadvertent form of expression, not particularly noticed by me till after publication, and has probably given more pain to myself than to any one else.

In adducing the quotation which refers to Sir John Herschel, my opponent chooses to omit the preceding sentence, which notices his recognition of *the influence of the earth's rotation on the general winds;* this being the very cause which I then ventured to suggest as the most influential in their production. That Sir John Herschel has not thought himself accused and denounced in any of my remarks, I have good reason to believe.

It may be well to inform my opponent that I am not one who has "forgotten" that the aqueous ocean of the globe, no less than the superincumbent atmosphere, is subject "to the gravitating power" and the influence of "the rotary and orbitual motions of our planet:"† But does he mean to maintain that these influences must produce aqueous movements of equal velocity with those of the same influences in the atmosphere—even as apart from the question of gyration? At a proper time there can be shown him, not "torrents in the ocean," but a system of *currents* in the several oceans, which fully exemplify the great physical truth which he has volunteered to aid me in asserting. [Par. 45.] Nor need he apprehend any conflict on my part with the views of observant geologists: While his "perfect equilibrium" will be found to preclude a "perfect" repose, either of the aerial or aqueous coverings of the planet.

I had noticed Dr. Hare's error in alleging that I reject the influence of heat. In repeating this allegation, he now intimates that "It is very possible that his opinions may have changed since he read my "*objections;*" but that he DID REJECT THE INFLUENCE OF HEAT‡ when the preceding and following opin-

* This Journal, Vol. XXVIII, p. 316.

† See this Journal, Vol. XXV, p. 131, also this volume, p. 152.

‡ In cases of quotation, where it is proper to notice the bearing of particular words or phrases, I adduce these in small capitals, as above; but have not felt myself at liberty to follow the example of Dr. Hare, in italicising sentences and fragmentary quotations, as if they had been put forth in the same emphatic forms by the writer.

ions were published must be quite evident." And he then adduces the fragment of a sentence, "*Were it possible to preserve*," &c. [par. 46.] Now whether this passage be most remarkable for the self-complacency or the pertinacious unfairness which it exhibits, I shall leave unprejudiced readers to determine. That my opinions have not changed since I read Dr. Hare's "*objections*," the following quotation may serve to show; and as it is a portion of the very paragraph from which he has here quoted, and part of the same article in which the alleged "denunciation" of the meteorologists occurs, it could hardly have escaped his eye or memory. I said, (this Journal for 1835, Vol. XXVIII, p. 317,) "I 'freely ADMIT that HEAT IS OFTEN AN EXCITING as well as modify-'ing CAUSE of *local* WINDS, and other phenomena, and that it HAS 'an incidental or subordinate ACTION (though not such as is usu-'ally assigned) in the organization and DEVELOPMENT OF STORMS, 'and that, in certain circumstances, IT INFLUENCES the interposi-'tions of the moving strata of the atmosphere. Its greatest DIRECT 'INFLUENCE is probably EXHIBITED in what are called LAND AND 'SEA BREEZES, or in the DIURNAL MODIFICATIONS which are EXHIB-'ITED by regular and GENERAL WINDS. But, so far from being the 'great prime mover of the atmospheric currents, either in produ-'cing a supposed primary north and south current, or in any other 'manner, I entertain no doubt, that if it were 'possible to pre-'serve [as Dr. H. then inaccurately quotes] the atmosphere at a 'uniform temperature over the whole surface of the globe, the 'general winds could not be less brisk, but would become more 'constant and uniform than ever.'" And with all this before him, he reasserts that I rejected THE INFLUENCE OF HEAT! If greater injustice has been manifested in any scientific discussion of the present century, it has not fallen under my notice.

But as I may have been more frequently misunderstood on the subject of the action of heat and rarefaction than perhaps any other, I will avail myself of this opportunity to say, that in my first paper (this Journal, Vol. xx, p. 18) I had quoted from Dr. Hare a few sentences which, so far as they went, expressed my notions then, and which I have never yet found any reason to change; and I concluded what I said then upon the subject of heat in these words: "To create in the midst of these equable 'winds or elsewhere, by the aid of rarefaction, a fanciful vacuum 'into which the atmosphere from a distance of many miles, and

'even many hundreds of miles, is to rush with all the fury of a 'storm, is to do violence to the established principles of natural 'science. To ascribe such effects to such a cause, is no better 'warranted than to refer all storms to the direct influence of elec-'tricity and magnetism."—Can it be that this summary rejection of "the influence" of "electricity" has occasioned the infliction of the "Objections," "Strictures," and "Additional Objections?"

It seems to dissatisfy Dr. Hare, that I should have stated the proper inquiry to be *What are storms?* and not *How are storms produced?* He asks, "suppose that before ascertaining *how* fire is produced, chemists had waited for an answer to the question, *what is fire*, how much had science been retarded?" [47.] But, waiving the lack of analogy between fire and storms, suppose that in treating of fire, one philosopher should mean by it the heat of combustion; another the heat and smoke, maintaining that the fire depended on the latter; while a third should view it as comprising both these, together with all the effects produced in the surrounding air: would not the proper inquiry then be, *What is fire?*—It appears evident that the laws and phenomena of storms must be first ascertained and established, ere we can successfully investigate their origin or primary causes. And this principle, I trust, has hitherto guided my inquiries.

Dr. Hare appears unwilling to relinquish the grateful task of rendering obnoxious the phrases "grand error" and "school of meteorologists;" which he honors with oft repeated notice. He speaks also of "an endless controversy,"—in which he has chosen to volunteer, and which he prefers to carry on by criticisms instead of abiding the issues of fact, even when these have been presented by himself. He says, To follow me "in detail through all the misunderstandings which have arisen, and which would inevitably arise during a continued controversy, would be an Ixion task." It may be, that grace to acknowledge "the misunderstandings" which the controversy had brought to light, would have tended greatly to shorten its duration.

In paragraphs 49 to 52 Dr. Hare has expended his labors on some superfluous suggestions in my earliest paper, which, more than three years since were virtually withdrawn, and the public notified of their relinquishment;* but which, after all, seem at

* See note prefixed to my article on hurricanes, Vol. xxxv, p. 201 of this Journal. Also in Nautical Magazine for January, 1839.

this time to be held in more favor by Dr. H. than by myself. In par. 51, with characteristic fairness, he has joined a passage from the same paper to another from a subsequent paper, and has adduced it, with a formal reference, as a continuous quotation from the latter. I see little advantage, however, that he can derive from it: The "unresisted rotation" refers to the seeming non-resistance of the air to a mass turning on its own axis: And did he never know the *rotative* velocity of a moving body to "become accelerated" by the oblique "resistances" of other bodies with which it came in contact?

In par. 53–56 my opponent labors to convict me of inconsistencies in various passages which he has culled from my reply to Mr. Espy in the "Franklin Journal;"—as if any inconsistencies of mine could disprove the rotative and progressive character of storms. The alleged inconsistencies result only from his confounding cases which I view as distinct, and from some inaccuracies in the choice of terms.—This labor is also continued on a collection of passages on the barometer. [57–61.] Had our objector given as much attention to the operations of nature in the open air, as he has to the phenomena exhibited in the laboratory, he could not by any possibility have fallen into the error which is exhibited in these paragraphs. It is singular enough that a critic who has detected so much of what he has pleased to fancy inconsistencies and contradictions in my writings, should have failed to perceive that the space "around the exterior border" might, nay indeed must be something very different from the "first portion" or "last portion of the gale." Observation has shown that most of our winter storms are preceded by a high state of the barometer, and that the beginning of the storm is shewn by the falling of the mercury, which rises when the heart of the storm or gale is passed and the wind changes.

Of inaccurate or fictitious quotation, I am sorry to notice an example in "the *reliable facts and observations of our theorist;*" [par. 62]—exhibiting a manner of controversy which can in no wise contribute to the advancement of science. Of the quotation which is here adduced, I believe that not more than three words can be found together in my writings.

In his criticisms on my statements of the changes of wind in storms, [62–68] Dr. Hare fails to notice the distinction between "*suddenly*" and *immediately*, in passages which in their ori-

ginal state and connexion are perhaps sufficiently correct; and he would make the statement of an *exception* which "sometimes happens," to be a contradiction or neutralization of the "evidence," or general result. Had he observed sufficiently he might have found, that his fancied analogy derived from the rotary action of a solid, is entirely inapplicable to the case of natural eddies and whirls, produced in part by a gravitating or centripetal force acting from the exterior. He might thus have learned that his hypothetical statement of the law of rotation in fluids does not, at least in all cases, agree with fact, and can in no way alter or affect the vorticular or other rotative action exhibited in nature. Nor can he disprove or annul the fact, that an immediate or a sudden change does takes place only at the circular *inner margin* of the violent part of a regular and extensive whirlwind storm.

His implied allegation [69] that "there is no evidence" that the wind was more violent on the southeastern* side of the gale of August 17th, 1830, than on its northwestern side, is opposed by the testimony of Capt. Waterman of the Illinois and the log-book of the ship, as compared with observations made at the same time on the opposite or northwestern side of the gale.—It was on or near the central line or axis of this storm, that only southeasterly and northwesterly winds were exhibited.

Dr. Hare has inferred that "in no case would the inner portion of the southeastern and more violent limb" of a gale or hurricane "be beyond the cognizance of our merchants and insurers;" and then says, that "experience shews, that every northeaster brings in a crowd of vessels having only to complain of the violence not the direction of the wind." [70.] But, do the alleged "crowd of vessels" come from far in the southeastern offing? The storm of August 17th, 1830, was at New York a strong "*northeaster*," and would the Illinois, in the Gulf Stream off Nantucket, have found no cause to complain of the "direction of the wind" if bound to New York or Philadelphia?—this ship having had the wind set in at "south," and veering "first to southwest, then to west and northwest," a "perfect hurricane!" "*Experience*" has shown,

* This I believe to be Dr. Hare's meaning; for the word "southwestern," I deem to be a misprint: else Dr. H. fails to understand himself in this passage; for there is nothing in my views or in the nature of the case, which requires the wind to be stronger on the "southwestern" *side* of a storm than on the "southeastern" side.

that in these violent gales, while blowing northeasterly on our shores, the wind becomes more easterly, southerly, and southwesterly, in proportion to the distance from the coast, thus producing a dangerous cross sea; and "our merchants and insurers" have, unfortunately, been too often cognizant of the destructive effects.

In par. 71–74, Dr. Hare shows that an isolated and defective passage on the phases of hurricanes in the West Indies, which he adduces, is not in all respects reconcilable with the local changes in such storms, considered as moving whirlwinds. There are at least two ways by which this labor might have been lessened or avoided: first, by quoting the next sentence, which suggests qualifications; or second, by referring to the same number of this Journal, Vol. xxv, p. 114–121, where the phases of these gales in the western Atlantic are particularly set forth, with a key for suiting these explanations to the West Indian seas; viz. that in the latter, the direction of the wind, in the corresponding sides and phases of the storms, is "about ten or twelve points of the compass MORE TO THE LEFT, than on the coast of the United States in the latitude of New York."

In the next place, Dr. H. endeavors to show [75–77] that I seem to suppose whirlwinds as capable of being "self-induced." In justice to his readers, however, he should have quoted the entire paragraph from which he has cited my remark "that whirlwinds and spouts appear to commence gradually and to acquire their full activity without the aid of any foreign causes." (This Journal, Vol. xxxiii, p. 61.) But can Dr. Hare prove to us, "the aid of any foreign causes?" It is proper to note here, that by the above remark I did not intend to exclude the influence of atmospheric pressure and elasticity, nor changes of temperature and density in and about the body in which gyration is induced. Neither do I disconnect or "isolate" the spirally ascending central motion from the great body of the tornado or whirlwind, as he attempts to do for me.

Dr. Hare finally declares, [78] "I do not deem it expedient to enter upon any discussion as to the competency of the evidence by which the gyration of storms has been considered as proved."—The friends of science will doubtless be surprised at this. For, if Dr. H. did not intend to discuss the "*evidence*" of gyration, for what useful purpose did he "enter the lists?" or why did he

attempt to show facts in disproof? Was it more important to array criticisms and speculations than to bring the question to the test of strict observation and induction? And will not this evasion be received as proof of the weakness of his cause? He says that the competency of the evidence has by Mr. Espy been "ably contested." But has it been so contested by that writer, as to be decided adversely in the mind of any strict and careful inquirer? Even if Dr. H. should admit gyration to be "sufficiently proved," and "should consider it as an effect of a conflux to SUPPLY an upward current at the axis," would not this imply a *self-elevating power* in this "upward current?" And would not the admission of gyration decide the question in my favor?

But he adds further: "Yet the survey of the New Brunswick tornado, made on *terra firma* with the aid of a compass, by an observer so skillful and unbiassed as Prof. Bache, ought to outweigh maritime observations, made in many cases under circumstances of difficulty and danger." Now let me ask—Is gyration disproved by this survey? I trow not: and apprehend that I have sufficiently shown its results to have been consistent with a general rotative action.*

Still unwilling to admit rotation, he appeals to the storm of December 21, 1836, in the terms which follow.

"In like manner great credit should be given to the observations collected by Prof. Loomis respecting a remarkable inland storm of December, 1836. This storm commenced blowing between south and east to the westward of the Mississippi, and travelled from west or northwest to east or southeast, at a rate of between thirty and forty miles per hour. [?] There appears to have been within the sphere of its violence an area, throughout which the barometric column stood at a minimum, and towards which the wind blew *violently* on the one side only from between east and south, and on the other only between north and west. [?] This area extended from southwest to northeast more than two thousand miles. Its great length in proportion to its breadth seems irreconcilable with its having formed the axis of a whirlwind. [!] The course of this storm, as above stated, was at right angles to that attributed by Redfield to storms of this kind. [!] (Trans. Am. Phil. Soc. Vol. 7.)"

We have it here asserted that "this storm" . . . "travelled from west or northwest to east or southeast:" and that, "The course of this storm, as above stated, was at right angles to that attributed by" me to other storms. While at the same time we are told that the area, "throughout which the barometric column

* Article on the New Brunswick tornado, in this Journal, Oct. 1841, Vol. XLI, p. 69–79.

stood at a minimum," . . . "extended from southwest to northeast more than two thousand miles." Now, in all storms which I have noticed in this part of America, the course and progress of the barometric minimum appears coincident with that of the body or axis of the storm; and as the length of the track thus passed over, is quite a distinct thing from the *length* of the storm itself, or from the "area" of the barometric minimum *at any given moment of time*, it appears to follow from Dr. Hare's own statement, that the course of the proper body or axis of the gale was *northeasterly; coinciding with the course of other storms.* Moreover, I have not yet seen any evidence which shows that even *one* storm of magnitude in the United States has proceeded in a *southeasterly* course; although such a conclusion has been suddenly adopted, ere now,* apparently with the hope of escaping from a dilemma in which some favorite hypothesis had become involved.

I am aware that in his elaborate account of this storm and its attendant phenomena, which I greatly value, although dissenting from some of his conclusions, Professor Loomis alleges that "in this case there was no whirlwind." I will only remark, that to me the characteristics of this storm appear to be those of a diffused overland gale of the whirlwind character; the only observations obtained being on the right hand of the path of its axis. I understand, also, that other inquirers have been led by the evidence to the same result.

The manner in which Dr. Hare has described this case, shows very strongly the importance of the inquiry, *What are storms?* For, was it the area of the minimum depression of the barometer—or the area of violent winds—or the area of the rain—or the area passed over by the wave of barometric oscillation—or the area of extraordinary changes of temperature—which constituted the proper limits or identity of this storm?†

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* Not, however, by Prof. Loomis.

† So far as definitions only are concerned, and these are important in science, it may be proper to adduce the following from Webster, our lexicographer.

"STORM, *n.* A violent wind; a tempest. Thus *a storm of wind,* is correct language, as the proper sense of the word is rushing, violence. It has primarily no reference to a fall of rain or snow. But as a violent wind is often attended with rain or snow, the word *storm* has come to be used, most improperly, for a fall of rain or snow without wind."

We now arrive [par. 79] at Dr. Hare's own views of the origin of storms. These, whether "thunder gusts, tornadoes, or hurricanes," . . . "he had considered, and still considers, to be mainly owing to electric discharges between the earth and the sky, or between one mass of clouds and another." (This Journal, Vol. XL, p. 44.) With this theory or hypothesis, I have no particular concern in this defensive discussion; and shall therefore make but few remarks on the subsequent portion of his paper, which is mainly a reprint of matter which was subjoined to his "objections and strictures," as these first appeared in the Lond. Ed. and Dub. Phil. Magazine.

In either "disruptive" or "convective" discharges of electricity, I discern nothing which can originate or maintain those violent movements of the air which constitute a storm. If the atoms of air are to perform the functions of electrified "pith balls," or "pendula," and thus make a hurricane, (!) it would seem necessary to place them in such space as would admit of their free action, and where their motions could hardly constitute the *wind* or movement in mass of a dense body of atmosphere which is under a compression more than equal to twenty eight inches of the barometric column. There can be no previous "blast of air" to aid the "convection," as this convection is itself supposed to furnish the blast. Nor has any "alternate" or vibratory motion in the air, passing to and fro between the electrified surfaces of the earth and the clouds, been discovered in storms; which, on the "convective" hypothesis, ought to constitute their chief violence. Besides, the cloud *itself*, the probable *result* of the tornado or storm, must first be produced, ere such "convection" could be called into action.

"The disruptive process," as "exemplified by lightning," appears wholly incompetent in itself or its causes "to produce convective discharge upon a scale," equalling in constancy and mechanical effect the force which is "exhibited in tornadoes and hurricanes." [81.] And if it were otherwise, the action of a hurricane or tornado, on this hypothesis, must cease on the occurrence of a "disruptive" discharge; but such discharges appear to cause no cessation in the mechanical force of these storms.

The rising of "misty vapors resembling steam," from the surface of a river, in a tornado, again comes to us transformed into "the rising of the water:" [82] although, had the water thus

risen, I see not how it could give strength to Dr. Hare's electrical hypothesis; there being a known upward mechanical force in the *wind*, at the center of a tornado.

The allegation that the injurious "effects upon the leaves of trees," [83] . . . "cannot be explained without supposing them to have been the medium of an electric discharge," appears quite gratuitous: the mechanical violence of the wind which is witnessed in the severest storms, bruising and tearing off the leaves by thousands, seems an obvious and adequate cause of the injury which the remaining leaves sustain.

If a "convective discharge takes place between a stratum of air in proximity to the earth and a stratum in the region of clouds," [84] it must, as before suggested, be through a reciprocating or vibratory medium, the *downward* motions of which should every where be nearly equal to the *upward;* and there would be no occasion for the *horizontal* motion which constitutes the main force of hurricanes, tornadoes, and other storms. Such vertical motions could hardly take place; and if occurring, could not escape detection.

The reasoning adduced by our author against Mr. Espy's theory, [85] seems conclusive: but it appears not to strengthen the electrical hypothesis.

The alleged electrical relations of the earth's atmosphere, [88–90] if correctly stated, must always exist; and cannot serve to explain the action of storms, which, conforming to the usual course of the great winds, pursue regular geographic routes, unchanged by the electrical qualities of the surface over which they pass.

Neither violent winds nor rains are commensurate with, nor always incident to "a local diminution of atmospheric pressure." Instead of alleging the latter as "demonstrably a cause of wind and rain," would it not be more philosophical and correct to consider diminutions of pressure as the *effect* of certain mechanical movements in the atmosphere? which often occasion rain as well as winds. [91.]

Have "those enormous discharges of electricity which take place during hurricanes," as alleged, [92] been proved to occur either uniformly or generally? And could these discharges cause or constitute the hurricane? If so, let the *modus operandi* be shown.

If it be true, "that moist, foggy or cloudy air is not a conductor of electricity," [93, etc.] does it not follow that any "convective discharges" will seem to be confined solely to the vibratory or alternating motions of the air itself. It appears inconceivable, how the air, either in mass or atoms, can exhibit such movements of transfer and with all the power and velocity of a hurricane, either in *one* direction only, or in opposite directions, at a given time and place. Besides, an effective vibratory action between two distant surfaces with both which the vibrating body is in full contact, appears impossible. Nor would even such alternating action enable the convective discharge to pass through the vibrating stratum of air.—These passing remarks, however, as already suggested, are not needful for sustaining my views of whirlwind storms against the animadversions of my opponent.

Since the discoveries of Franklin, an electrical origin and character has often been conjecturally ascribed to storms. A want of originality in advancing this electrical hypothesis, will not weaken any evidence which shall be adduced in its favor; but, until it shall have been satisfactorily supported by observed phenomena, it will probably continue to be rejected by scientific inquirers.

There seems to be an evident improvement in Dr. Hare's views of whirlwind action, since entering upon this controversy. Nor do I doubt that the subjoined notices of the effects of the Providence tornado, as observed "on *terra firma* with the aid of a compass," will receive from my readers an impartial consideration.

On the Evidence of a general Whirling Action in the Providence Tornado.

On the 30th of August, 1838, between the hours of 3 and 4 P. M., a violent whirlwind or tornado visited the town of Providence, in the State of Rhode Island. It was preceded by a violent shower of rain of short duration, after which the tornado appeared, appended to another cloud, and passed through the southern part of the town nearly from west to east.

Its earliest ravages reported, were in Johnston, at the farm of Mr. Randall, about seven miles west from Providence. From this point it passed on through Cranston and Providence, where,

crossing the river into the State of Massachusetts, it passed through Seekonk, Rehoboth, Swansey, Somerset, and as far, at least, as Freetown, beyond Taunton river; a distance of twenty five miles from the point first mentioned.

The width of its visible track, as indicated by the prostration of trees, fences, and other objects, varied from a mere trace in its narrowest, to two hundred yards or upwards in its widest portions. Having, a few days after the occurrence of the tornado, carefully examined the track for the distance of about seven miles, on each side of Providence river, I propose to offer some of the results of this examination, together with such remarks as may seem justly deducible from the effects observed.

So far, however, as the impressions made on an accidental eye-witness of the tornado may be important, we have a valuable account furnished us in the letter of Zachariah Allen, Esq., of Providence, which is given in Dr. Hare's notice of this tornado. [This Journal, Vol. xxxviii, p. 74–77.] Mr. Allen had the advantage of viewing its progress from a point near its path. He calls it a "whirlwind," and describes its phenomena in a manner perfectly consistent with this appellation. "The circle formed by the tornado" on the river, he describes as "about three hundred feet in diameter," and mentions, that the "misty vapors" . . . "entering the whirling vortex, at times veiled from sight the center of the circle, and the lower extremity of the overhanging cone of dark vapor:" and that "Amid all the agitation of the water and the air about it, this cone continued unbroken," &c.

This "cone" of the tornado of which he so often speaks, it should be noted was an *inverted* one, the smaller end of which was sweeping on the earth's surface.* Thus he gives the instance, "when the point of the dark cone of cloud passed over the prostrate wreck of the building, the fragments seemed to be upheaved," &c. It will be seen here that the *prostration* of the building had preceded the arrival of the center or "point" of the

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* We may properly conceive of this "cone," in tornadoes or water-spouts, as including not only the visible clouded condensation here described, but also the invisible portion of the whirlwind which surrounds the narrow and depending portion of the visible cone, below the general line of condensation. This *entire* body of the whirlwind is generally a truncated cone; its smaller and most active end sweeping along the surface of the earth or sea.

"cone;" showing that the whirlwind often acts on a large area, with great force, *externally* to the lower part of the *visible* cone, or the column of vapor at its axis. Moreover, the substances which by the center of the tornado were "uplifted high in the air," were "left to fall from the OUTER EDGE of the black conical cloud."*

Mr. Allen says further, "The progress of the tornado was nearly in a straight line, following the direction of the wind, with a velocity of perhaps eight or ten miles per hour. Near as I was to the exterior edge of the circle of the tornado, I felt no extraordinary gust of wind; but noticed that the breeze continued to blow uninterruptedly from the same quarter from which it prevailed before the tornado occurred. I also particularly observed that there was no perceptible increase of temperature of the air adjacent to the edge of the whirlwind, which might have caused an ascending current by a rarefaction of a portion of the atmosphere."

Soliciting a careful attention to the observations of Mr. Allen, who is well known for his intelligence and his habits of correct observation, I proceed to give some account of my own examinations of the traces of this tornado.

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* Mr. Allen states that the form of the cloud and of the cone of vapor depending from it so nearly resembled the engraved pictures of 'water-spouts' above the ocean, that he should have come speedily to the conclusion that one of these 'water-spouts' was approaching, had he not been aware that "this phenomenon occupied a space in the heavens directly above a dry plain of land." Perhaps it might be inferred that Mr. A. had partaken of the too common notion, that the misnamed *water-spout* is, or should be, literally a *spout of water*. This phenomenon, so much talked of among mariners, proves to be nothing more nor less than the visible inverted "tapering cone of vapor" or condensation, noticed by him as "extending from the cloud to the surface of the earth," *at the axis or ascending portion of the whirl;* if we may at all rely on the results of extensive examinations and comparisons of the accounts of 'water-spouts' and their effects. The same appearance was observed in the New Brunswick tornado by experienced seamen navigating the Raritan river, who at once pronounced it to be a water-spout, and took their measures accordingly. It is probable, however, that most of the 'water-spouts' noticed at sea, are inferior in size and energy to these destructive tornadoes.

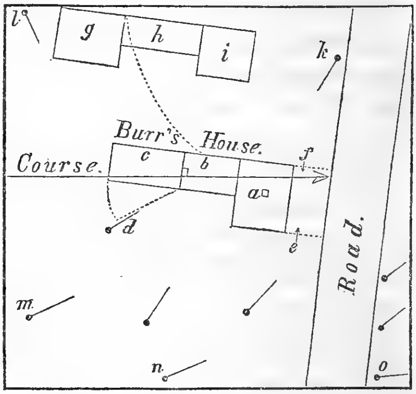
A 'water-spout' was seen by Messrs. Tyerman and Bennett near Borabora in the Pacific, which extended nearly horizontally from one cloud to another directly over their heads; and no harm done! The most credulous will hardly conceive this to have been *a column of water*, or even approximately such: besides, no sea-water has ever been known to fall from the clouds. Similar 'spouts' have been seen by others; and I once beheld a magnificent example of this kind, in one of the interior towns of Connecticut; which probably indicated an axis of rotation nearly horizontal.

From a point on the rocky "ledge" north of the turnpike road and nearly three miles westerly from Providence, to the house of John Burr on the Cranston road, a distance of about one and a quarter miles, I found the course of the tornado to have been S. 86° E. by compass, over a plain country. The magnetic variation being here about 8° westerly, makes the true course E. 3° N. From this point to Providence river, a distance of about two miles, the course was five degrees more northerly.

I agree with Dr. Hare that the general effects observed on this track were "quite similar" to those of the New Brunswick tornado; and will give such of my sketches, formerly prepared, as will best illustrate this similarity and the general effects here mentioned.

The following is a sketch of some of the effects on the farm of Mr. Burr: His house is about one mile and a half from the Providence bridge.

Fig. I. *Providence Tornado.**



In this figure, *a* represents a wooden dwelling-house of two stories with chimney at its center: *b* a dwelling added to *a* and extending to the rear: *c* a lighter building about 16 feet by 30, attached to the rear of *b*: *g* was a large wooden barn: *h* a long building or shed extending from the barn to the carriage-house *i*. The width of the visible track was here about five hundred feet, and the course of the center or axis of the tornado appeared to have passed somewhat diagonally over the three first named buildings.

The house *a* withstood the shock, receiving some damage; the chimney top of *b* was thrown on the roof of *a*, perforating the same, while *b* was unroofed and greatly injured, and a long timber or *sill* from the shed *h* broke endwise into the upper part of the house *b* from a northwesterly direction. The building *c* was turned more than twenty feet to the *left about*, as regards the axis of the whirlwind, against the top of the prostrated pear tree *d*, and was there overturned upon it. There were twenty one persons in *a* and *b*, including a school of children, none of whom were seriously injured.

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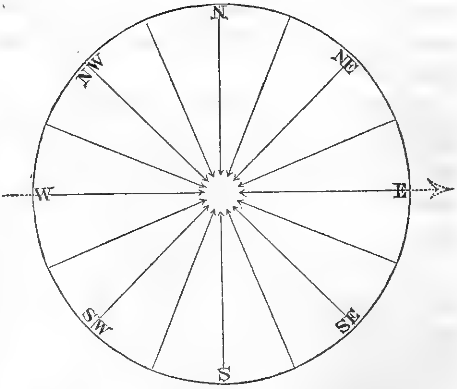
* On these plans the large dot at the end of the several short lines, shows the original position of the root of the tree; the pointed end of the line shows the direction of its top.

The barn g and the shed h were destroyed, and the materials swept off toward the first named buildings. A corn-house, standing on the same side with the barn, is stated in the Providence papers to have been blown over to the *west*, but I can find no notes of my own respecting the direction of its fall.

The effects here exhibited appear to me to be due to a progressive whirlwind, revolving to the left; for we may notice, as in the New Brunswick tornado, a more onward direction in the trees prostrated on the *right* of the axis, d, m, n, o, &c., than on the left side; while the outermost prostrations on the right, n, o, point still more nearly than the average on this side, to the course of the tornado: And on the left side of the track we have the tree k in a direction inclined several degrees *backward* from the course of the storm. The value of these indications of whirling action I have endeavored to point out in my remarks on the New Brunswick case. [This Journal, Vol. XLI, p. 70–75.]

At the front of the house a, however, were two slatted dooryard fences, extending from the house to the road. The fence e was overthrown northward toward f, and the fence f in the contrary direction towards e: both directions being *transverse* to the line of the axis, which passes between them. Such cases have been adduced as supporting a directly inward course of the wind in the body of the tornado; or, as indicating two bodies of opposing wind meeting on a central line; but I draw a different conclusion.

Fig. II.



Let Fig. II represent, horizontally, the directions of such center blowing winds in the body of the tornado, and let it be supposed as passing over the area of Fig. I, without revolving, so as the course of the center will coincide with the arrow which indicates the course of the axis on that figure. It may thus be seen that on this hypothesis the wind must strike the fences e, f, either parallel to their length, or but little oblique; a direction of wind which seldom or never

prostrates fences, even in the path of a tornado. Besides, *near the center* of such an inward blowing tornado, where only it could act on these fences with *lateral* force, such winds must necessarily become neutralized both by blowing against each other and by turning upward to escape, thus having little effect at this point, within four feet of the ground. I say nothing here of the possibility of any winds blowing *with violence* in such central directions; which I could never conceive: For the entire spaces between the centripetal lines of arrows must be conceived as being filled by the affluent winds; the lines only indicating their directions.

But on the other hand, let us suppose a strong whirlwind passing in the same direction: the front half of which, both on and near the line pursued by its axis, must necessarily sweep laterally across this line, first *northwardly* towards *f*, if it be revolving to the left; and the last half of the whirl on its arrival will sweep *southwardly* towards *e*. That only the fence *e* was thus prostrated by the first wind of the tornado may be explained by the protection afforded to *f* by the house, against the *advancing* whirl, and perhaps here, also, by the spirally *upward* tendency towards the center, in the wind which thus came round the southeast corner of the house, prostrating *e* in its course. But on the passing of the axis of the whirl, the wind would recur with increased force from the opposite direction, upon the fence *f*, prostrating it towards *e*; while the latter, being already down, and in turn partially protected by the house, would remain as it first fell.

In passing over the track of the tornado between Burr's house and Providence river, several instances and groups of prostration were observed. But owing to the open character of the grounds throughout most of the track, the memorials afforded by the trees were less frequent than have been seen in other cases.

Near the Pawtuxet turnpike, the tornado encountered a new house belonging to Mr. Gardner. This house was in the southern portion of the track *on the right of the axis,* and was removed and turned several feet, *towards the left.*

It is proper to mention here that the *order of changes* in the wind's *direction*, viewing the tornado either as a whirlwind, or, as claimed by Mr. Espy and seen in figure II, would at any *fixed point* on this the right side of the track, be successively *towards*

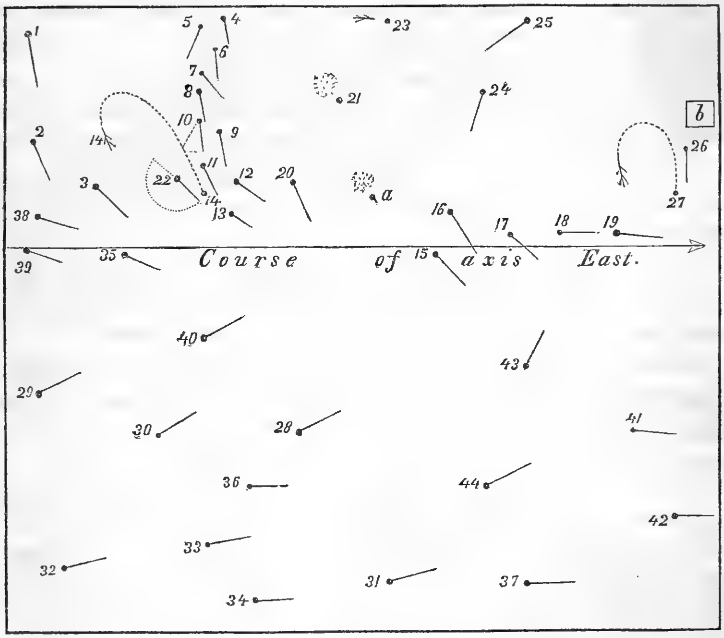
the right, as relates to the center of the tornado. But this building having received its motion by yielding to the wind, shows the true course of the latter as whirling to the left.

Passing by the prostration of the range of buildings near the river, described by Mr. Allen, I proceed to notice the effects which appeared on crossing to the Massachusetts side.

From the bank of the river to the house of Abraham Tifts on the Lyon farm, three fourths of a mile, the grounds were open and unbroken, being mostly under cultivation and with few trees exposed to the tornado, excepting an orchard of scattered apple trees westward of Tifts' house. The traces of the wind in and adjacent to this orchard were very distinct in their character, and I subjoin here the sketch on which they are represented.

Fig. III. *Providence Tornado.*

North or left side.



South or right side.

Explanations of Fig. III.—The cases of prostration 4 to 14, were from a line of small locust trees on the west border of an old apple orchard, and are severally shifted a little out of line for the sake of a distinct exhibition of their directions.

From thence to near Tifts' house at *b*, the ground is but slightly foreshortened, and the relative positions of each tree, on the left of the centre, is approximately

shown. The figure was drawn from my field notes on account of the distinct phenomena which were exhibited on this part of the track, and which, in cases *a*, 14, 22, 21, 23, and 27, show conclusively the first action of the whirl *across the path of the axis*, and sweeping towards the northern border of the track. On the opposite or right side of the axis, southward of 15, there were no trees exposed, and the effects of the tornado were here visible only on the crops and fences. Therefore the cases shown on the figure south of the axis, and also westward of 22 on the left side, were brought in from the more western parts of the track between the orchard and the river, and include all the prostrations from the latter to Tifts' house; and their relative distances from the axis or center of the track are but approximated.

Case 14, represents a small locust tree broken off at an old wound near the root and carried *outward and backward* into the adjoining fallow field, having struck into the ground seven times in its course, leaving distinct traces. It was finally left at a point N. 57° W. from its stump, at the distance of forty yards, with its top turned southwardly, in conformity with its two last traces in the soft ground.

Case 10, a small locust tree was prostrated S. 25° W., leaving its mark in the fallow ground. It was subsequently shifted, by the progressive change in the whirlwind, to S. 11° E.

Case *a*, an old apple tree with but a single branch projecting southwardly from its trunk; this branch was taken off by the onset of the tornado and struck into the ground northwest from the trunk, depositing its apples at this spot. The limb itself was missing.—Case 21, apples deposited as in case *a*.

Case 22, a small wild cherry tree, was found lying on and against the stump of 14, having first been thrown *from the latter* by the onset of the wind and subsequently swung round by the south to its present position, as appeared by the impressions made in the ground. Its final position was such, as if occurring at the outset would have prevented 14 from being carried off northwesterly.—Case 23, the branch of an apple tree was thrown west.—At *b* is shown the relative position of Tifts' house.

Case 27, shows the original position of a large pear tree, the stem of which was broken off and first thrown northward, where it ploughed up the soft ground of the garden by its force, and continued its circuit to a point northwest of its original position, where it remained with its top turned toward the south.

For the purposes of a general comparison, the observed or first known directions of the prostrations on the two sides of the track may be summed up as follows.

Left or North side of the Track.

Case.	Direction of first prostration.	Inclination inw'rd and backw'rd fr'm course of tornado.
38	S. 74° E.	16 degr's.
39	S 70° E.	20
35	S. 67° E.	23
1	S. 10° E.	80
2	S. 23° E.	67
3	S. 45° E.	45
4	S. 12° E.	78
5	S. 35°W.(backw'rd)	125
6	S. 5° E.	85
7	S. 40° E.	50

Right or South side of the Track.

Case.	Direction of first prostration.	Inclination inw'rd and backw'rd fr'm course of tornado.
29	N. 65° E.	25 degr's.
32	N. 77° E.	13
30	N. 60° E.	30
33	N. 80° E.	10
34	N. 88° E.	2
36	East,	0
40	N. 65° E.	25
28	N. 63° E.	27
31	N. 75° E.	15
44	N. 63° E.	27

Left or North side of the Track.

Case.	Direction of first prostration.	Inclination inw'rd and backw'rd fr'm course of tornado.
8	S. 11° E.	79 degr's.
9	S. 10° E.	80
10	fell S. 25 W. turned to S. 11 E.	115
11	S. 26° E.	64
12	S. 55° E.	35
13	S. 55° E.	35
14	first thrown N. 23 W. (backward)	247
15	S. 45° E.	45
16	S. 30° E.	60
17	S. 55° E.	35
18	East,	0
19	S. 85° E.	5
20	S. 27° E.	63
21	N.55°W.(backw'rd)	215
22	first fell N. W. turned to S. 37 E.	225
a	N.45°W.(backw'rd)	225
23	Branch of apple tree thrown west	183
24	S.20° W. (backw'rd)	110
25	S.55° W. (backw'rd)	145
26	South,	90
27	first thrown N.10 W.	260

Right or South side of the Track.

Case.	Direction of first prostration.	Inclination inw'rd and backw'rd fr'm course of tornado.
37	N. 87° E.	13 degr's.
43	N. 30° E.	60
41	S. 85° E.	– 5
42	East,	0

Mean direction of prostration on the right side of the track N. 73° E.: average inclination inward from course of tornado, *seventeen degrees.*

Mean direction of first prostrations on the *left side* of track, S. 4° W.: average inclination inward and backward from course of tornado, *ninety four degrees.*

Relative inclinations of the two sides to the line of axis, more than *five* to *one.*

It is proper to mention, that the average inward inclination of *all* the prostrations on the *right* side of the track for a distance of four miles east of the river was thirty degrees.* This however does not affect the conclusions in favor of rotation to the left.

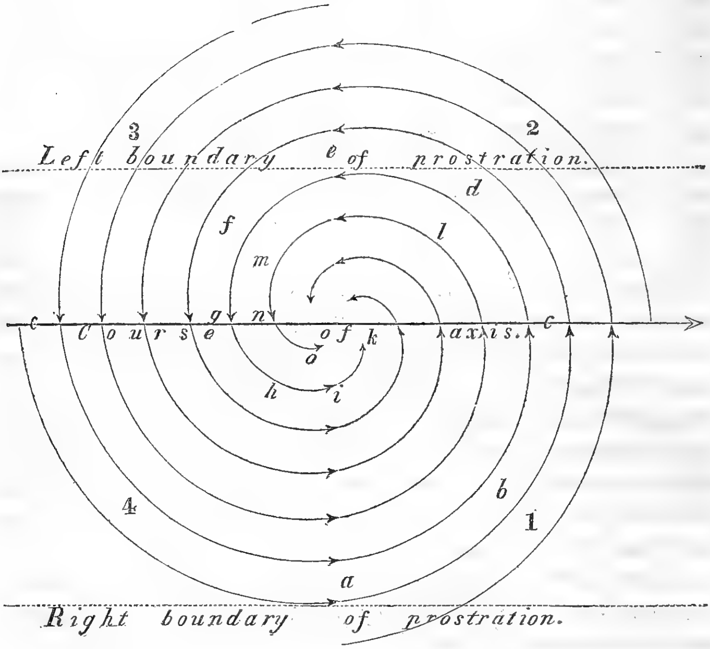
These average results, on the two sides, together with the observations already adduced, appear to me to afford decisive evidence of whirlwind rotation in this tornado, in the direction from right to left or which is contrary to the hands of a watch. In reference to this evidence and that exhibited in my paper on the New Brunswick tornado, I add from my prepared sketches the following figure, as an approximate illustration of the whirling action in these tornadoes, so far as this may be shown *horizontally* and by a stationary figure.

Let the involuted lines or arrows on this figure be supposed to represent the motion of the wind at or near the bottom of a vertically cylindrical portion of the center of a tornado, comprising a length of radius equal to the greatest width of the prostrating power on the right of the axis of its path. Now if the tornado

* This larger average gives a relative degree of inclination on the two sides of *three* to *one.* Nearly the same difference is found in two outside bands of prostration, of equal widths, (Tables I and V,) shown in my survey of the New Brunswick Tornado. See this Journal, Vol. XLI, p. 78.

be considered as whirling in the manner here represented, but *without any change of location*, its action may be supposed as concentrically equal on all sides; the motion, however, becoming quickened towards the center in the *inverse ratio* of the successive concentric areas: that is, each particle of air as it revolves about the axis, *continuing to describe nearly equal areas in equal times*, in its progress towards the center, where it rises spirally in the direction of discharge; this direction being vertically at the center, the point or area of least atmospheric resistance or pressure. Thus, the course of a single particle, horizontally, may be *a b c d e f g h i k*;—and so on or between each of the four involuted lines which constitute the figure.

Fig. IV.



For further reference, we may divide this figure by the cross lines of arrow heads, into the four quadrants 1, 2, 3, 4.

We will now consider this whirl as having *a constant progressive motion* on the line of the long arrow *c c*, at a rate equal to one fourth or fifth of its average rotative velocity. It will then follow, that as the force of the whirl on the trees and other ob-

jects encountered by it, is *as the square* of the wind's velocity at the point of impingement, the relative effects on the two sides of the line of the axis, which before were equal, will now be greatly altered.

For, if at a given distance *on the right* of the advancing axis, the former velocity was 80, it will now, as relates to the earth's surface, have become 100; and at the same distance on the *left* side the velocity of the wind will be reduced to 60, as relates to the earth's surface. Thus the squares of these effective velocities will give a power relatively equal to 100 at the former point and only 36 at the latter; both being equally distant from the axis. Hence, although the *rotative* velocity of the whirl decreases rapidly as we recede from its axis, yet its *prostrating* power will, by its progressive motion, become greatly extended on the *right* side of the advancing axis, and proportionally contracted on the left side. Thus the respective boundaries of the prostrating power on the two sides of the tornado, when thus in motion, may be those indicated on the figure; which nearly correspond to the effects which have been observed in several cases.

It may be seen further, that *nearly all the prostrations* near the line of the axis and elsewhere, must, by the advancing motion of the tornado, receive a direction *more onward* than is represented by the arrows or lines in the figure, which can represent only a stationary rotation.

In further considering these effects, in different portions of the whirl, as it encounters objects in its advance, we shall find the maximum effects to be mainly on the line *a*, *i*, *o*, at the rear of the *first quadrant*. Hence, if a tree on this side the axis should fail to be prostrated till after the first quadrant had passed over, it would not be likely to fall in the fourth quadrant, on the further advance of the tornado, unless very near to its axis. Moreover, if one tree should fall when under the more advanced portion of the first quadrant, another if prostrated later in the same quadrant, must necessarily fall in a *more onward* direction than the first, and if sufficiently near will lie across the latter.

It may likewise be seen, that the wind of the whirl in passing into the *second quadrant*, on the left side of the track, is sweeping *backward*, and with its effective power thus greatly reduced, as regards fixed objects on the earth's surface. Thus the limits of prostration are not only narrowed, but the effective power is

here greatly reduced, and gives *fewer prostrations* than under either the first or third quadrants. The *minimum* of effect occurs on the arrival of the line *e k*, at the rear of the second quadrant.

But on the arrival of the *third quadrant*, the prostrating power on the left side becomes more and more efficient by the ceasing of the backward and the accession of the progressive movement; and at or near the line of *f m*, it again takes effect, with rapid increase. The destructive force is also much augmented here by the greater velocity of the heart of the whirl, near its axis, and the impetus must rapidly increase in energy to its maximum effect, as at *m n o*, taking off any tree which may here remain, and carrying aloft, or sweeping onward, the objects previously prostrated on the line *c x k.*

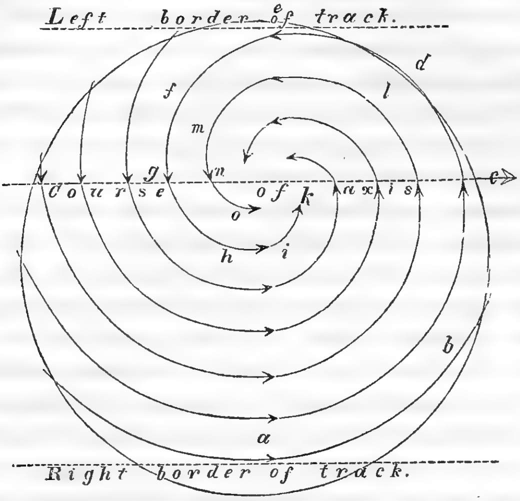
If a tree on the *left* side of the track falls on one previously thrown down by the tornado, the last fallen will also have the more onward direction, as on the other side: unless both have fallen in the second quadrant, where few prostrations occur.—The *fourth quadrant*, for causes noticed in considering the *first*, can have little prostrating effect, except perhaps on the small area near its axis.

If we now conceive of our figure as applied only to the limits of prostration or destruction which constitute the *visible path* of the tornado, it becomes apparently and relatively unequal, in its right and left hand quadrants, the axis appearing greatly eccentric, and in the same degree, at least, as the *left* band or belt of prostrations is found narrower than that on the right of the axis. This apparent, but illusive form of the whirl, may be illustrated by fig. V; which is drawn on the same lines with the preceding figure.

It will readily be seen that this eccentricity of the axis, on the visible track, will be in proportion to *the progressive velocity of the tornado;* other things being equal. Thus, if Mr. Allen be nearly right in his estimate of the rate of progress in the Providence tornado, the eccentricity shown in its path would be generally less than is shown in figures IV and V. On the other hand, if the progressive velocity should be as great as Professor Loomis informs me he ascribes to the tornado of February last, in Ohio, viz. about forty miles an hour, the eccentricity would in such a case be greatly increased, showing the axis as far out-

ward, perhaps, as would be in line with *m*, or *f l*, in these two figures.

Fig. V.



From this examination it appears to result, that an observer who follows the track of a tornado after its departure, will find on one side of the apparent axis of its path, *if it be a whirlwind*, a continued series of prostrations pointing almost invariably onward and inward, with various degrees of inclination to the course of the path. While on the other side of the axis, a narrower band or belt of prostrations will be found, which are also inclined mainly inward and onward, but showing greater inclinations from the line of progress, together with frequent cases which incline more or less backward and sometimes even outward from the course of the tornado.

It may also appear, that a want of proper attention to the necessary conditions of the prostrating power in a progressive whirlwind, can alone induce us to ascribe such effects to supposed antagonistic winds, blowing simultaneously in opposing directions.

Leaving, for a moment, the more tangible features of this inquiry, we may now take some notice of the more outward portions of the "cone" or whirlwind, which are supposed not to be comprised in figure IV. Assuming here the involuted and inward motion, with its upward discharge at the centre, it follows that the impulsive accession of air which is necessary for main-

taining a violent whirlwind action, must come in horizontally, and in the same gradually involuted courses; or, must descend in like manner from a higher region, in and around the outward parts of the whirling cone. I have long since been led to believe that this impulsive accession comes from *both* these sources, but *chiefly from the latter;* and that this motion of accession and support is spirally *downward* in the outward portions of the whirl. The latter being, in its higher portions, often greatly expanded, as noticed by Mr. Allen.

The evidence on which this opinion rests, can be but partially alluded to here; but I will suggest the following considerations: —1. The ascertained existence of a stratum of unusually cold air in the higher region of clouds, on some particular days remarkable for the occurrence of numerous thunder gusts and tornadoes:* 2. The observed descent of a portion of the clouds in front of the nucleus or body of a heavy squall or tornado, which may sometimes be traced by the eye as low as the existing limit of condensation will afford opportunity for observation: 3. The fact noticed by Mr. Allen and others, that adjacent "to the exterior edge of the circle of the tornado" or whirlwind, the previous breeze often continues "to blow uninterruptedly from the same quarter" as before:† 4. The last fact, when taken also in connexion with certain peculiar and striking effects in the outward portions or edge of the tornado, a knowledge of which I have gathered from various sources: 5. The coldness of the air which has been noticed at the edge of a whirlwind: 6. The instant penetration of the lower end of the whirlwind into thick forests, and into hollows and ravines, which has been frequently noticed: 7. The direct memorials of downward action in the outward portions of the whirl which I have myself met with, on the tracks of different tornadoes.

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* This change of upper temperature I think can be clearly made out on the day of the New Brunswick tornado, which was but one of many tornadoes and thunder gusts which appeared in this part of the United States on the same day; and on the preceding day in Illinois and other western states.

In the New Haven Gazette are accounts of *five* severe tornadoes which occurred in the states of New Jersey, Connecticut, Massachusetts and Rhode Island, on the afternoon of August 15, 1787. I can also refer to many more recent cases of this kind.

† The observation here quoted is one of many which show the error of the very hasty generalization which alleges a circuit or annulus of calm air to have been observed *on all sides* of tornadoes and hurricanes.

In most of the foregoing remarks it has been my design to view the tornado as it moves onward, in full action. Of the origin or incipient causes of the whirl, it is not necessary here to inquire: although some clue to these is perhaps afforded us in the considerations above noticed.

Recurring once more to the track of the Providence tornado, I have to state that eastward of Tift's house the course of the track soon became S. 65° E. magnetic, for more than two miles. It then took the course of S. 75° E., and further onward the tornado passed directly over the house of Solomon Peck, about four miles from Providence. This house was partly unroofed; chimney thrown down; windows broken *inward*, as in many other cases; and much other damage was also done to Mr. Peck's property. In passing onward towards Taunton river the tornado appears to have preserved an inclination to the south of east: the track, though slightly sinuous, appearing, like that of the New Brunswick tornado, to form part of a great curve, with its convex side to the northward.

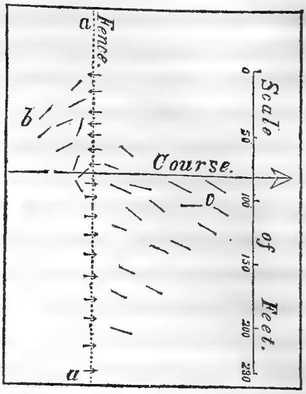
On the track from the Lyon farm to Peck's house there were many interesting memorials which might confirm the deductions already made. On some portions of the track, also, the tornado appeared to have risen almost entirely from the surface, its reversed apex leaving but a narrow trace, and on some fields, even no trace at all. But in these cases, as on the tracks of other tornadoes, the compass bearing did not fail to lead the explorer to new ravages, where, at times, the energy of the tornado appeared to be greater than before.*

Before we take leave of the traces of this tornado I would adduce another of my prepared sketches, which shows the rotative effects in a manner which I think should satisfy the most strenuous opposer of whirlwind action. In this sketch, Fig. VI, we have represented a portion of the track which crossed at right angles a line of weak post-and-rail fence, *a*, *a*. On the *right* of the axis, this fence was prostrated *eastwardly* or in the direction of the course of the tornado, as shown by the short arrows which may represent the posts of the fence; the rails also having been scattered onward and inward, towards *c*, in the general manner rep-

* This is not uncommon in tornadoes, and is especially noticed in the account of two "Trombes" which are given in Pouillet, Elemens de Physique et de Météorologie, § 655.

resented in the figure. On the *left* side, however, every post was prostrated *westwardly*, and the rails were likewise blown slightly backward toward *b*, in the same general direction. The scale of feet, which measures across the track, was obtained by estimating twelve feet to each length of the rails. The locality of this sketch was perhaps a mile eastward of the Lyon farm. —The application of the foregoing views of rotation to this case, it can hardly be necessary to point out.

Fig. VI. *Providence Tornado.*



I have noticed many effects of similar kind on fences; but that the *backward* prostration on the left side of the track should have taken full effect in this case, and mainly, perhaps, under the second quadrant, I ascribe to the age and general weakness of the fence.

Additional memorials might here be adduced in evidence, and of similar character to the foregoing; but having already occupied more space than I intended, I must now leave the question of a general whirlwind rotation in this and other tornadoes to the candid consideration of impartial inquirers.

New York, July 12, 1842.

Art. III.—*On a Tornado which passed over Mayfield, Ohio, February 4th,* 1842, *with some notices of other Tornadoes;* by Elias Loomis, Professor of Mathematics and Natural Philosophy in Western Reserve College.

(Communicated to the Conn. Acad. of Arts and Sciences, April 28, 1842.)

On the 4th of February, 1842, between four and five o'clock, P. M., a tornado of destructive violence was experienced in the northeastern part of Ohio. It commenced near the south line of the township of Mayfield, in latitude 41° 31′ N., longitude 81° 27′ W., and pursued a course N. 33½° E. for about twenty four miles; when meeting Lake Erie, it left no further traces of its progress. A more distinct idea of its course may be formed

by inspecting Plate IV, Fig. 5. From this it will be seen that the tornado passed not far from the centre of Mayfield; over a corner of Chester; near the centre of Kirtland; over corners of Mentor and Concord; and directly over the southeast part of the village of Painesville. It is said that no trees are prostrated one hundred and fifty rods south of the south line of Mayfield. Immediately on receiving intelligence of the disaster, Prof. St. John and myself started to survey the ruins, and the subsequent observations were made by us jointly. In measuring the track, each of us carried one end of the chain; and in taking the bearings of prostrate objects, Prof. St. John usually observed the compass, and I recorded the readings. We surveyed the track with special care in Mayfield, Kirtland, and Painesville, and crossed it at other places. Our first observations were made in Mayfield in the vicinity of Chagrin river. Plate IV, Fig. 1, gives a view of this part of the track. This was near the commencement of the tornado, and was also the scene of the greatest violence. The bed of the Chagrin is depressed about three hundred feet below the general level of the surrounding country. A section shewing the undulations of the ground is exhibited in Plate IV, Fig. 2. In Fig. 1, A A A, B B B are trees chiefly of the variety called whitewood. Their average size is from two to four feet diameter, and they were mostly prostrated. The ground descends at first gently, afterwards quite abruptly, to the bed of the river. The forest approaches within about a hundred rods of the river, yet upon this slope the small timber was not greatly injured. The larger trees were mostly prostrated. C represents the house and barn of Chester Ellsworth, not much injured; D, the house of Ezra Carpenter, chimney blown off; E, his barn entirely demolished; F F, woods; G, log house of Mr. Alderman, entirely destroyed; H, house and barn of Anthony Sherman, entirely destroyed; I, Benjamin Wilson's hay barn unroofed; K, another hay barn unroofed; L, Samuel Dean's large framed house, torn entirely to atoms; M, school house, entirely destroyed; N N N, O O O, trees entirely uprooted or broken off; P, a log cabin with north side of roof taken off and a few shingles from the windward side. Beyond P a line was measured with a chain perpendicularly across the track two hundred and thirty rods.

Mr. Halsey Gates, standing near his mills under a shed open to the north, saw the tornado pass, and observed it very atten-

tively. The entire heavens, he says, were covered with dense black clouds moving with great rapidity. No cloud seemed to descend to the earth; yet the progress of the tornado was marked by a huge column of a dull yellow or smoky tinge, a representation of which is given on Plate IV, Fig. 3. The lower half of this column was quite dark, so that objects could not be seen through it; the upper half was lighter, and had several vertical stripes somewhat like the shadows of clouds, or like a cloud at a little distance from which a heavy shower is falling. This column was estimated to be about eighty rods in breadth, was much agitated and moved rapidly forward to the northeast. But little rain fell—in the dialect of our informer, not enough to wet a man's shirt. Some hail fell about the size of buck shot, but not enough to whiten the ground; it was quite soft and porous. It lightened several times quite sharp just before the blow came on, striking a tree at no great distance; and thunder was distinctly heard above the roar of the tornado. This roar was almost deafening, and was compared to a heavy surf upon the sea-shore, or to the Falls of Niagara. The house D was not much injured; The east side was well spattered with mud, and the chimney blown N. 55° W. The house bears from the barn E, N. 62° E. distant sixty six paces. The barn E was lifted entire from its foundation and carried N. 30° W. It contained at the time three tons of hay and four horses. The bottom dropped at a distance of fourteen paces; the other heavy timbers were carried much farther, and lighter objects, such as boards and shingles, were strewn over an area of several acres. Three men were in the barn at the time; they state that the barn was not lifted more than a few inches, but rather slid from its foundations. They made their escape as the barn began to move. A hat belonging to one of the men was carried four miles in the direction of the track. The grass in the vicinity of the barn was beaten down flat upon the ground as by a heavy roller, and all turned N. 48° W. The house G was a log house which had the appearance of having been blown up with powder. The wind first burst open a door—then lifted the building *en masse* from its foundations—the logs opened—the power of the wind upon the building was broken—the logs fell back again nearly upon the foundations—a part of the timbers however being carried some distance N. 27° W. A flock of hens was carried off in the tornado, and they

have not since been seen. One goose near the house had its wings and legs broken, and was almost entirely picked of its feathers; it was carried N. 20° W. The house and barn H were entirely destroyed—mostly carried N. 88° E. Hay from the barn was carried S. 87° E., leaving a perfectly distinct track upon the ground. The chimney of the house was carried S. 50° E. Mr. Peleg Sherman, a half mile distant on the north side of the track, observed the tornado as it passed. Solid hail fell here three quarters of an inch in diameter—not half enough to cover the ground. There was but little rain. An orchard in front of G and H was almost entirely destroyed. Two apple trees were torn up by the roots and carried N. 8° W. fifteen paces, leaving several marks where they struck the ground at intermediate points. Another tree was carried N. 23° E. thirty paces; another sixty paces in the same direction. Several trees had their limbs on the southwest side twisted round the body of the tree by west and north, and left half broken, pointing towards the northeast; while those on the northeast side were wholly uninjured.

In crossing Chagrin river, the tornado appears to have elevated considerable water into the air. The general impression among the inhabitants is, that the bed of the river was left entirely dry, although from the previous rain its height was said to be two feet greater than it had been before for four years. The river varies from twelve to sixteen rods in breadth. There are distinct marks of a considerable rush of water on the Eastern banks. A saw log twelve feet long and three feet diameter, known by its mark, and supposed to have been floating in the river at the time, was found after the tornado about twenty rods from the bank on the east side. The house L appears to have been near the seat of greatest violence. First the cheese house was taken, was carried N. 18° W. sixty feet, and striking the ground was dashed in pieces. An old log house near by, was carried N. 35° W. A south door of the dwelling house blew open—a boy about eleven years old attempting to shut the door, was whirled through a *window* just burst open, and carried N. 65° E., a distance of fourteen rods as measured by us with a chain. Here he was deposited, having received no other injury than a slight scratch upon the face. On looking back for the house he found it gone. It was a large two story framed house, quite new, and remarkably well built. It was lifted entire from its foundations, carried N. 46° E. a dis-

tance of forty four paces—where it struck a tree; the bottom fell; the upper timbers were carried various distances, the clapboards were broken to shivers and lie mostly strewed on the hillside, which rises on the northeast, some lying loose upon the ground, and others sticking fast in the soil. Clapboards of the usual size and pieces of flooring with square ends were driven obliquely into the ground from six to twelve and even eighteen inches, and some with sharp ends to the depth of two feet. The soil is chiefly of clay, was at this time drenched with rain and was almost entirely free from frost. The land was not ploughed but covered with the usual turf. Other fragments of clapboards from this building, easily distinguished by their red color, are found strewed through the woods to the north and east, and some are said to have been discovered at a distance of seven or eight miles. The chimney of the house was carried N. 40° E., the ridge N. 30° W. A number of apple trees near by were almost entirely stripped of their bark, probably in consequence of the cudgeling they received from sticks flying in the air. Four geese were found dead in this vicinity without any material loss of feathers. A large barn, containing ten tons of hay and a ton of straw, was unroofed and carried N. 25° E. six feet. A corn house, containing two hundred bushels of wheat and corn and three barrels of salt, was also unroofed and moved from its foundations northward,—the west corner four paces, the east corner two paces. It ploughed into the ground, throwing up earth to the height of a foot or more, particularly at the northwest angle.

The school-house M was lifted entire from its foundations, carried N. 10° W. twelve paces, and dashed upon the ground. The fragments were scattered as usual. The hill towards the northeast was covered with a very heavy growth of timber,—hemlock, beech, oak, &c. of vast size. Scarce a tree of any importance now stands entire. The breadth of the track at this place was measured with a chain, 230 rods. Two waggons were carried off in the tornado, and only one wheel has since been found.

The following data will enable us to estimate the velocity of the tornado's progress. I requested Mr. Gates to follow in imagination the smoky column as he saw it advance from its first appearance to its disappearance; and with a watch in my hand noted the time. The mean of three such trials, which were tolerably consistent with each other, was fifty two seconds. Dis-

tance travelled estimated at three fourths of a mile, which is a velocity of fifty two miles per hour. According to the best testimony I could obtain, the tornado passed Chagrin River at a quarter past four; passed Painesville a quarter before five. Velocity seventeen miles in thirty minutes, or thirty four miles per hour.

I have obtained an independent estimate of the velocity, in the following manner. The tornado accompanied the change of wind from south to west, which was experienced over a large territory. This change of wind was at Hudson cotemporaneous with the barometric minimum, and it is presumed to have advanced with nearly the same velocity. I have therefore sought for barometric observations, and have obtained them for the fourteen following stations. The time of barometric minimum is not in all cases the time of the lowest observation, but is obtained by projecting the observations on paper and comparing the curves at the different stations.

Station.	Time of minimum.	Station.	Time of minimum.
Natchez, Miss.	1842. Feb. 3, 1 P. M.	Uniontown, Pa.	1842. Feb. 4, 7 P. M.
St. Louis, Mo.	" 4, 2 A. M.	Gettysburgh, Pa.	" " 11 "
Cincinnati, O.	" " $0\frac{1}{2}$ P. M.	Rochester, N. Y.	" 5 1 A. M.
Marietta, O.	" " 4 "	New York City,	" " 5 "
Hudson, O.	" " $4\frac{1}{2}$ "	New Haven, Ct.	" " 7 "
Detroit, Mich.	" " 5 "	Providence, R. I.	" " 10 "
Meadville, Pa.	" " $6\frac{1}{2}$ "	Boston, Mass.	" " 10 "

From these data we find the progress of the wave to be in the direction N. 62° 19′ E., and velocity 30.05 statute miles per hour. But the course of the tornado was N. 33° 30′ E., inclined 28° 49′ to the progress of the wave. The velocity of the wave in the direction of the tornado's progress was then 34.3 miles per hour, a result almost identical with the second estimate. The first estimate can only be regarded as a good guess. The tornado then travelled a space equal to its breadth, at Mayfield, in seventy-five seconds.

The velocity of the wind's motion however at points of the most destructive violence, was far greater than this. A tolerable idea of its velocity may be gained from the distance to which light objects were driven into the ground. Small pieces of clap-boards with square ends were driven into turf land eighteen inches, and with sharp ends two feet. What charge of powder is capable of producing the same effect? According to the experiments of Dr. Hutton, (Tracts, Vol. 3, p. 214,) a pound ball of cast iron fired

from a gun of two inches calibre into solid blocks of elm wood, in the direction of the fibres, penetrated the following distances:

With a charge of 2 oz. powder,	velocity 800 feet per second,	penetration	7 inches.
" 4 "	1200	"	15 "
" 8 "	1600	"	20 "

Dr. Hutton estimates the resistance of elm timber $7\frac{1}{3}$ times more than that of firm earth. A pound ball with a velocity of 800 feet should then penetrate the earth 51 inches. The depth penetrated being assumed to be as the square of the velocity, a pound ball fired with the velocity of 550 feet would penetrate 24 inches. The space penetrated is said to be as the specific gravity of the ball. A wooden ball two inches in diameter, specific gravity .75, fired with a velocity of 550 feet should then penetrate firm earth 2.4 inches. As this last result is a deduction from principles somewhat doubtful, I desired to verify it by experiments of my own. A six pounder was accordingly charged with $1\frac{1}{4}$ pounds of powder. Two or three short pieces of oak board, three inches wide and one inch thick, were added, and the gun pointed towards a steep hill distant about a rod. The boards penetrated the ground a few inches, were badly shivered and bounded some distance up the hill. A second experiment was tried with nearly the same result. The hill was of usually firm earth but not stony. The greatest penetration did not exceed six inches. Velocity computed 1000 feet per second. According to the former data, the penetration should have been nearly eight inches. But the ground at Mayfield was saturated with water. I have no precise data for estimating the allowance required by this circumstance. I judge however that it would not increase the penetration more than threefold. We arrive then at the conclusion that the clap-boards at Mayfield were driven into the earth with a velocity of 1000 feet per second or 682 miles per hour.

I do not by any means suppose that the velocity was the same throughout the entire track. On the southeast half, probably the velocity did not exceed three times the progressive motion of the tornado.

Let us now determine the directions of the wind. For this purpose we measured the bearings of about seventy prostrate trees extending across the track in the direction N O. We did not attempt to measure the bearings of all indiscriminately, for this would have been a hopeless task. The prostrate trees are only

to be counted by thousands. We searched particularly for trees *crossing* each other. We found but one such case on the south-east half of the track, and this was near the middle. The bottom tree fell N. 20° E.; a second upon it N. 56° E; a third upon the second N. 84° E. We measured a number of single trees on the side N N, the bearings of which were N. 3° E., N. 3° E., N. 3° E., N. 14° E., N. 19° E., N. 25° E., N. 27° E., N. 30° E., N. 30° E., N. 55° E., N. 55° E., N. 55° E., N. 60° E., N. 60° E. The trees were not arranged in the order I have here given them, but lay scattered about indiscriminately. There did not appear any very decided mean difference in the bearings of the trees throughout the entire space N N N. We endeavored to obtain the greatest range of bearings. This appears to be 81°. From the case of the trees which crossed, it may be inferred that the most northerly trees are those which fell first. The mean of the most northerly half is N. 14° E., of the others N. 57° E.

On the other side of the track the phenomena were exceedingly different. Here we had no difficulty in finding trees which lay across each other, and accordingly we measured few others. The following observations were made, commencing near the centre of the track and proceeding towards the northwest border. Fifteen groups were measured in which the trees crossed at a considerable angle. The first mentioned tree in each group lay at the bottom, the others above it in the order named. Five layers were recorded in several instances. This was by no means the whole number which lay on top of each other. Frequently several trees lay nearly parallel with the one observed. The observations are intended to include the whole range of directions.

1. N. 70°W.; N. 10 E.; N. 82 E.
2. N. 2 W.; N. 85 E.
3. N. 28 W.; N. 20 W.; N. 85 E.*; N. 55 E.
4. N. 55 W.; N. 32 E.; N. 32 E.; N. 55 E.; N. 68 E.
5. N. 35°W.; N. 35 E.
6. N. 40 W.; N. 17 W.; N. 55 W.*; N. 25 E.
7. N. 80 W.; N. 85 E.
8. West.; N. 28°W.; S. 40 E.*; N. 75 E.
9. N. 35°W.; N. 20 W.; N. 85 E.
10. S. 5 W.; S. 80 W.; N. 80 E.; S. 70 E.; S. 60 E.
11. N. 25 W.; N. 25 E.; N. 60 E.; N. 68 E.; S. 83 E.
12. N. 25°W.; N. 26 E.
13. N. 60 W.; N. 20 E.
14. N. 60 W.; N. 20 W.; N. 15 E.; N. 65 W.*; N. 17 E.
15. N. 40 W.; N. 35 W.; N. 10 E.; N. 62 E.

Mean of the bottom trees N. 55° W.; top trees N. 62° E.; intermediate trees N. 16° E. Here is a remarkable uniformity which cannot be ascribed to accident. The bottom tree points invariably westerly, and the top tree easterly. To this there is *no exception.* The directions of the intervening trees are intermediate between the extremes, passing round in the order west, north, east. To this rule there are only four exceptions marked with an asterisk. The direction of the third tree in the third group differs 30° from that of the fourth; the third tree in the sixth group differs 38° from the second; the third tree in the eighth group differs 65° from the fourth; the fourth tree in the fourteenth group differs 80° from the third. These are the anomalies 30°, 38°, 65°, 80°. How are they to be explained? Do they invalidate the inference which naturally follows from the other bearings, that the wind on this part of the track revolved in the direction west, north, east? I think not. For first, the exceptions are but four to fifty two, or one to thirteen cases. Second, it is not to be supposed that the rotation of the wind was absolutely uniform like the motion of a clock. In the case of what passes for a rectilinear current, the wind often veers by jerks back and forth from its mean direction through an arc varying from 50° to 90° in five minutes. The *mean* variableness at Hudson for an interval of five minutes is 42°; so that it could not be deemed surprising if objects prostrated by what is called a rectilinear current should often differ in their directions by this amount. But thirdly, the direction of the principal roots of a tree will somewhat influence its fall; and finally where thousands of trees are falling at the same instant, as in the present case, in a dense forest, their tops must frequently interfere, and a tree be turned greatly from the position it would otherwise occupy. The force of this last remark will be perceived when it is considered that the tornado had entirely passed in seventy five seconds, and its most destructive violence probably did not exceed fifteen seconds. It should however in candor be admitted that some of the disturbing causes here named would have less influence, from the extreme violence of the wind.

If the motion of the air were merely centripetal, that is, directed in right lines from the circumference of the tornado to the centre, then the phenomena on the two sides of the track should be perfectly *symmetrical,* and a diagram of the directions of prostrate

objects upon one side, if revolved about the central line, should answer equally well for the other side of the track. How far this is conformable to observation has already been seen. The entire range of prostrate trees on the right side is 90°, on the left 360°. Such a supposition then in the present instance is wholly inadmissible.

For determining the motion of the wind we have the following data. On the southeast half of the track the wind began on an average blowing towards N. 14° E., and ended N. 57° E. On the northwest half, the wind began N. 55° W.; passed through N. 16° E.; and ended N. 62° E. The tornado advanced N. 33½° E. The destruction of timber on the northwest half was estimated to be double of that on the southeast. Perhaps this might be occasioned by a wind blowing with one half greater velocity. The same inequality in the wind's violence is indicated by the buildings. On the southeast half of the track no building suffered any greater damage than the loss of a roof. On the northwest half, every building except Dean's barn and corn-house was totally demolished, and these are supposed to have been saved by the weight of their load. Let the black arrows on Fig. 4, Plate IV, represent the quantity and direction of the forces in question. Each of these forces is the resultant of two others, one the progressive motion of the tornado, and the other its own peculiar motion. The latter was evidently much the greatest. From the extremity of each of the arrows set off in a direction S. 33½° W., a line representing the progressive motion. The dotted arrows will represent the motion peculiar to the tornado. With these for my guide, I have drawn lines representing the supposed circuit of the wind. Near the point of convergence of these directions the wind must have risen with prodigious violence. According to this diagram, the wind on the right side of the track must have begun generally to blow about N., and ended N. 60° E. At no place could the wind have blown more than a few degrees west of north; at no place could it have been quite east. Thus on the right side, the entire range of directions is included within 90°. On the left side of the central line, the directions comprise every point of the compass. On the line A C, the bearings commence N. 55° W., pass through N. 16° E., and end N. 62° E. This corresponds with the mean of the observations on page 285. A little farther to the left, the

bearings would begin from the west, and end northeast or east. Still farther they would begin southwest, and end east or southeast; and upon the extreme margin the wind would blow towards southeast. All this agrees remarkably well with observation. The house and barn H lay strewed between the directions N. 88° E., and S. 50° E.

We may now perhaps explain some of the anomalies noticed in the bearings on page 285. The anomaly in group third may perhaps be due to a more easterly motion of the whirl than at the fall of the fourth tree, or to the fact that being nearest the vortex the proper motion of the whirl was greatest, and the bearing of a tree consequently less influenced by the progressive motion of the tornado. This last cause might perhaps explain the anomalies in groups sixth and eighth. The anomaly in group fourteenth may perhaps require us to admit a slightly undulatory motion of the vortex, such as is frequently seen in small whirlwinds. In group tenth also, although the rotation is uninterrupted, the variety of directions seems most naturally explained by such a supposition. I think it moreover not improbable that the direction of the wind was materially different at different elevations above the earth's surface upon the same vertical line, so that the bearing of a prostrate tree might be influenced by its height.

We also observed the bearings of a good many fallen trees in the vicinity A A, B B, but the trees were here more sparse. Near A A, the bearings were all comprised between N. and N. 28° E. Near B B, the directions were about the same as at O O; but from their distance the trees seldom lay upon each other. Near the northwest border were measured N. 84° E., N. 88° E., N. 89° E., East, S. 82° E. In the vicinity F F the following observations were made.

1.	N. 42°W.
	N. 18 E.
2.	N. 80 W.
	S. 75 W.*
3.	N. 16 W.*
	N. 82 W.
4.	N. 67°W.
	N. 64 W.
	N. 62 E.
	N. 66 E.
	S. 65 E.
5.	N. 64°W.
	N. 24 W.
6.	S. 70 W.
	S. 87 E.
7.	N. 80 E.
	S. 50 E.
8.	N. 62°W.
	N. 70 E.
	N. 72 E.
	East.

These observations are similar to those made near O O, and present two similar anomalies, which I have marked with an as-

terisk. They may perhaps be due to the increase of velocity of the wind in approaching the vortex, as before remarked.

We next proceeded to the centre of Kirtland, where we undertook a similar investigation of the phenomena of the storm. Considerable rain fell here for about ten minutes—it was mingled with hail not much larger than a pea—broke some panes of glass—not enough to whiten the ground. Had rained about five minutes before the most violent blast came on. The high wind did not last above ten minutes—the most violent blast only three or four seconds. The air was filled with leaves and sticks, which made it quite dark, so that it was impossible to see but a short distance. It lightened three or four times before the blast—the thunder was quite loud. The best idea of the destruction will be gained by inspecting Fig. 6, Plate IV. A, was a log-house blown down; B, log-house demolished; C, barn unroofed; D, barn unroofed; E, barn and shop unroofed, house injured; F, north roof of barn taken, south roof uninjured; G, house uninjured; H, house unroofed, barn injured; I, north roof of one barn taken, entire roof of a second barn, house little injured; J, house shattered, wing entirely destroyed, barn demolished; K, house demolished; L, north roof of shop taken, shingles of barn all flew off at once like a flock of pigeons; M, house unroofed, child two or three years old crushed by the falling of the chimney, the only death occasioned by the tornado; N, Presbyterian meeting-house; east side moved north twenty two feet, the west side, having the cupola, moved twelve feet—about one third of the north roof taken and otherwise badly shattered; O, north roof of house taken, two barns unroofed; P, house unroofed; Q, house unroofed; R, roof injured; S, north roof taken, and chimney blown off. Where the ridge run east and west the north roof only was usually taken; where the ridge run north and south both were generally taken. The fact here stated was found to hold generally true, that the leeward roof was taken in preference to the windward one.

The following bearings of trees were taken in crossing a forest from T to U. At first few trees were found lying upon each other. The bearings were N. 65° W., N. 17° W., N. 12° W., N. 5° E., N. 7° E., N. 8° E., N. 10° E., N. 11° E., N. 15° E., N. 15° E., N. 20° E., N. 62° E., N. 78° E., N. 80° E. The following groups of trees lying upon each other were observed.

1	N. 2°W. N. 10 E.
2	N. 38 E. North *
3	N. 48 W. N. 22 W. N. 18 W. N. 11 W.
4	N. 32 W. N. 47 E.
5	N. 32°W. N. 25 E.
6	N. 68 W. N. 48 E.
7	N. 52 W. N. 70 W.* N. 11 W.
8	N. 32 W. N. 2 E.
9	N. 32°W. N. 18 W. N. 22 E.
10	N. 30 W. N. 8 E.
11	N. 62 W. N. 18 W.
12	N. 18 W. N. 8 E.
13	N. 48°W. N. 5 W.
14	N. 25 W. N. 2 W.
15	N. 78 W. N. 17 W.
16	N. 40 W. S. 65 W.* N. 25 W.

There is a perceptible difference between the phenomena here and at Mayfield. Upon the southeast side of the track the average direction is about N. 15° E. At Mayfield, it was N. 35° E. On the northwest side of the track, the average direction of the bottom trees is N. 43° W., and of the top trees N. 5° E. The phenomena are of the same kind, but the velocity of the whirl is much reduced. The rotation of the wind is still in the same direction. There are three anomalies here to be noticed, the most remarkable of which is the second tree in group sixteen, but as this was a small one its direction was probably influenced by the interference of other trees.

Our next particular survey was made at Painesville. The tornado passed directly over the southeast part of the village, but its greatest violence does not appear to have reached the earth's surface, as it did but little damage in the town. It blew off the balustrade of the Presbyterian meeting-house; took off a part of the shingles from an old roof, and removed the roofs of some small out-buildings. Hail fell as large as a walnut—quite solid, enough to whiten the ground—and broke a good deal of glass. Enough rain fell to lay the dust in summer—some thunder and lightning. Lasted but a few minutes. In the woods northeast of the village, on the opposite side of Grand River, there was a general prostration of the timber. The following bearings were observed, crossing from the southeast to the northwest side.

1	N. 57°E. N. 72 E.
2	N. 35 E. N. 55 E. N. 61 E.
3	N. 48 E. N. 62 E.
4	N. 38 E. N. 70 E.
5	N. 30°E.* N. 12 E.
6	N. 11 E. N. 15 E.
7	N. 20 E. N. 52 E.
8	N. 9 W. N. 7 E. N. 18 E.
9	N. 5°E. N. 22 E.
10	N. 4 W. N. 35 E.
11	N. 5 E. N. 22 E.
12	N. 9 W. N. 2 W.
13	N. 22 W. N. 12 W.
14	N. 17°W. N. 7 W.
15	N. 11 E.* N. 5 E.
16	N. 5 W. N. 18 E.
17	N. 15 W. N. 22 E. N. 47 E.

Here is the same rotation as at Mayfield and Kirtland, but the whirling motion is well nigh masked by the progressive motion of the tornado. There are but two anomalies, and these are so small as hardly to be entitled to the name. The mean direction upon the southeast side is N. 39° E. which is a little more easterly than at Mayfield. The mean direction of the bottom trees upon the northwest side is N. 7° W.; of the top trees N. 14° E. The phenomena are still of the same kind as at Mayfield and Kirtland, but less distinctly marked.

There have frequently been remarked in tornadoes places of interrupted violence. This was the case in the present instance, though I think this phenomenon may be ascribed in a good degree to inequalities in the surface of the ground. Thus at Mayfield, near A A, B B, the wind was well nigh irresistible. As the ground began to descend towards the river, the tornado seemed to continue nearly on the same level, and only reached the tallest trees. At about half a mile from the river, on the west side, it again struck the ground, and presently exhibited its greatest violence. As it met the hill on the east side of the river, it was forced to rise again, and near the brow of the hill its violence seemed fully equal to the greatest violence in the valley. The upward motion it had received in ascending this hill appears to have continued for some time afterwards; for although the subsequent ground was nearly level, yet at a distance of about a mile from the river, the trees were not generally uprooted, but broken off at an elevation of from twenty to forty feet. Again, at Painesville little damage was done to the town, while in the woods on the opposite side of the river, and nearly on the same level, almost every tree was prostrated.

I do not find, then, a uniform diminished action on the summits of hills, and increased action in the bottoms of valleys, as has been remarked in other cases. There were, however, some facts in the vicinity of the house L at Mayfield quite remarkable. Although the house was swept off by a wind having nearly the velocity of a cannon ball, several apple trees near by were not uprooted, and a row of bee-hives in the open air sustained no great damage. They were blown nearly a rod, and some so much injured that it was thought best to empty them entirely of their honey; but three hives are still in their places filled with bees, and bear no marks of the passage of a tornado. The barn

was about northeast from the hives, and probably offered them considerable protection. Their weight, which was about one hundred and forty pounds each, was probably their greatest security. Dean's wagon stood ten or twelve feet from the corn house towards his dwelling, and was not moved at all, although it might have been pushed along with one hand. The shelter was entirely blown away. So also the house D was but slightly injured, while the barn E, distant sixty six paces, was entirely demolished.

It has been remarked of other tornadoes, that objects did not seem to fall with the ordinary velocity of falling bodies. Some similar instances were observed at Mayfield, as for example the boy who was snatched out the house L and deposited uninjured at a distance of fourteen rods. There were other cases, however, in which bodies plunged into the earth as if shot from a cannon, as for example the clapboards into the side hill.

Another fact well worthy of remark is, that when the ridge of a building was turned towards the wind, both slopes of the roof were usually taken; but when the ridge was at right angles to the wind, if the body of the building was spared, the leeward slope was taken, usually entire, while the windward slope remained uninjured or escaped with the loss of a few shingles. The principle here stated is not peculiar to tornadoes. Many cases have been observed in which a rectilinear current produces the same effect. That the windward slope should stand in preference to the leeward is not strange, for the pressure of the blast holds it in its place. The elevation of the leeward slope has been ascribed to currents of air, which, forcing their way through the crevices of the building, impinge upon the opposite side and roof with sufficient force to burst an opening. That some such effect may take place I will not absolutely deny; yet the cause seems inadequate to explain the phenomena. Currents such as are here supposed should act with greater force against the vertical leeward side than against the roof, which is very oblique to the wind's progress. We ought then to find the leeward side forced off in preference to the roof, particularly as the weight of the roof coöperates with the nails to hold it in its place; and especially should this be true of barns, where the vertical boards are not in general very firmly secured. Not a single instance of this kind has however been observed. Moreover, the meeting-house

at Kirtland had a tight ceiling of plaster, without any opening to the garret; so that currents of air which might find their way into the building might strike upon this ceiling, but would be effectually cut off from the roof. The ceiling was uninjured, but a large hole burst in the roof. The reason then assigned, though admitted to be a *vera causa*, is wholly inadequate to explain the phenomenon. I ascribe it to a rarefaction of the air. A current of air forcibly impelled over an obstacle like the roof of a building, by friction drags along with it the air lying upon the leeward side of the roof, producing a partial rarefaction which might easily be sufficient to lift the roof. The degree of rarefaction requisite to produce the effect is much less than some might imagine. Suppose a barometer above the roof to stand only *one tenth* of an inch lower than within the building, we have an upward force of seven pounds per square foot, a force probably sufficient to throw off a considerable part of the barn roofs of Ohio.

In the tornado which occurred at Stow in 1837, a circumstance was remarked which I had never seen noticed before, that several fowls were picked almost clean of their feathers. In the New Haven tornado of 1839, the same fact was noticed. I made particular inquiry on this point at Mayfield. Four geese were found near Mr. Dean's house lying dead among the rubbish, without any perceptible loss of feathers. I heard of one goose so far stripped that its remaining feathers were not considered worth saving: its legs and wings were both broken. A turkey also was found lodged in a tree near Dean's, with the loss of about half of its feathers, and its bones broken. As electricity has been maintained to be the efficient cause of tornadoes, I have inquired whether this loss of feathers could be due to electric repulsion. I think not—Because first, the effect is not uniform; many fowls near the centre of the Mayfield tornado were killed but did not lose their feathers. Secondly, although electricity was manifested in the passage of the tornado, its intensity did not appear to be equal to that of a common summer thunder-shower. Thirdly, the effect may be explained by other causes known to be in operation. The gun mentioned on p. 284, was charged with five ounces of powder, and a chicken just killed added for a ball. As the gun was small, it was necessary to press down the chicken with considerable force, by which means it was probably somewhat bruised. The gun was pointed vertically upwards and

fired; the feathers rose twenty or thirty feet, and were scattered by the wind. On examination they were found to be pulled out clean, the skin seldom adhering to them. The body was torn into small fragments, only a part of which could be found. The velocity is computed at five hundred feet per second, or three hundred and forty one miles per hour. A fowl, then, forced through the air with this velocity, is torn entirely to pieces; with a less velocity, it is probable most of the feathers might be pulled out without mutilating the body. If I could have the use of a suitable gun I would determine this velocity by experiment. It is presumed to be not far from a hundred miles per hour. But it is said that a fowl carried off in a tornado floats with the same velocity as the current, and suffers no violence. This is only partially true. There is abundant evidence that in the Mayfield tornado the wind, at points but moderately distant from each other, was blowing in opposite directions and with very unequal velocities. A fowl floating in the air would at one instant fall in with a current moving with an accelerated and the next instant a retarded velocity. It might thus experience very sudden changes of velocity, amounting perhaps to a hundred miles per hour. The explanation here given derives confirmation from the fact that the fowls observed at Mayfield had both their legs and wings broken. Mr. Espy states, that he had been informed that fowls thus stripped of their feathers have not been killed outright, but have been seen walking about naked after the tornado passed.* Such was not the case at Stow or Mayfield, so far as I have been able to ascertain; and I have heard of no other instance in which the phenomenon has been observed except at New Haven.† A

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* At a subsequent date Mr. Espy communicates the following: "The information which I have received concerning the chickens and turkies remaining alive after being stripped of their feathers in a tornado, is verbal, and I have no doubt of the fact, though I cannot refer you to the authority by name. A gentleman told me that he saw turkies walking about naked after the passage of a tornado which occurred many years ago; but he added that *they soon died.* This was the first intimation I ever had of the fact, and he told it me as a strange phenomenon which came under his own observation."

Prof. C. G. Forshey, in a letter just received, writes thus:—"After the passage of the Natchez tornado in 1840, I saw many birds dead, generally not stripped; but a wild turkey I examined was almost featherless, and lying in a field half a mile from the woods. It did not occur to me to see if the bones were broken."

† I am informed by Mr. Herrick, that the fowls there were said to have run a few rods after being deplumed, but they soon died.

flock of fifteen sheep belonging to Mr. Alderman and near his house, was overtaken by the tornado. Six were killed outright, their legs were broken, and in many cases their entrails torn out; several of the living also escaped with broken legs.

Having thus discovered the true 'experimentum crucis' for analyzing the phenomena of tornadoes by observations of groups of trees lying upon each other, I felt desirous of applying the same test to the Stow hurricane, hoping it might remove the obscurity which still rested upon that subject. I immediately set out to re-examine the track. The traces of the hurricane were almost entirely obliterated, with the exception of those left upon the trees; and upon the north side of the east and west road, these being mostly fruit trees, had long since been righted. But in the front on the south side, particularly in front of the house G, (see this Journal, Vol. XXXIII, p. 369,) the trees remained almost without exception undisturbed, and I had no difficulty in recognizing individuals which I had before observed. The four trees particularly mentioned, p. 373, line 16, are undisturbed, as the track of the tornado is here as distinctly marked as it was the day after its occurrence. The following groups of trees were measured, the first being near the south border, the remainder towards the centre.

1	N. 30°W.	7	N. 46°W.	13	N. 45 W.	20	N. 43°W.
	N. 19 W.		North.		N. 68 E.		N. 22 W.
2	N. 42 W.		N. 46 E.	14	N. 33 W.	21	N. 34 W.
	N. 25 W.	8	N. 45 W.		N. 4 E.		N. 63 E.
	N. 22 W.		S. 43 E.	15	N. 39 W.	22	N. 66 W.
	N. 25 E.	9	N. 60 W.		N. 33 E.		N. 75 W.*
3	N. 40 W.		N. 32 E.	16	N. 63 W.		N. 38 W.
	N. 29 E.	10	N. 62 W.		N. 51 W.	23	N. 6 W.
4	N. 43 W.		N. 25 E.		N. 38 E.		N. 55 E.
	N. 39 W.		N. 54 E.	17	N. 32 W.	24	N. 37 W.
	N. 19 E.	11	N. 73 W.		N. 77 E.		N. 34 E.
5	N. 22 E.*		N. 30 W.	18	N. 40 W.	25	N. 43 W.
	N. 9 E.	12	N. 26 W.		N. 1 E.		N. 20 E.
6	N. 32 W.		N. 52 E.	19	S. 75 W.		
	N. 82 E.		N. 66 E.		N. 19 E.		

Here we have a well marked rotation of the wind, and only two anomalies, amounting to 9° and 13°. Mean of the bottom trees, N. 43° W.; top trees, N. 32° E.; remaining trees, N. 17° W. These are all upon the south side of the central line, or very near the centre. On the north side of the track I have no new

observations. Those recorded in my former article range between S. 54° W.; South; and S. 68° E. Near the centre were two trees, S. 82° W., N. 86° W. These trees, it will be observed, lie parallel with the track and almost directly in the centre. (See this Journal, Vol. XLII, p. 12.) This southwest wind on the north side of the track probably preceded the southeast, as the westerly wind preceded the easterly on the south side. We may then proceed to construct a diagram of the wind's motions as at Mayfield. The result is shown, Plate IV, Fig. 7. The motion is decidedly centripetal, with a slight tendency to revolve *with* the sun.

In order to obtain further light on the subject of tornadoes, I have paid some attention to those small whirls which are not uncommon in warm days, which last but a few seconds, and elevate light objects, such as leaves, dust, etc. March 31, 1838, about $11\frac{3}{4}$ A. M., I was walking alone in Hudson about half a mile west of the college. My attention was attracted by a roaring noise in a neighboring wood. I presently perceived a small whirlwind advancing into a cleared field, and marking its course by dead leaves which were elevated into the air to the height of pretty tall trees, and which revolved spirally upward *in the direction of the sun's motion.* The whirl advanced from S. 30° E. to N. 30° W., which was the direction of the wind at that time in this place, being somewhat of a ravine, although upon the hill at the college soon after, the wind was northwest. I followed it without any difficulty for several rods, until it came to a wood, where its force was very much broken, and it soon disappeared. I stood in the middle of the whirl and near its centre, and the wind blew with such force that I was obliged to hold my hat on, although the whirl advanced not more than three or four miles per hour. It crossed a small brook about five feet wide quite slowly, throwing up spray and a considerable quantity of water about a foot high, and for a diameter about the same. It lasted but a second or two, for the whirl passed nearly perpendicularly across it.

Aug. 22, 1838, 2 P. M. A whirl formed in the road directly in front of the college. It moved a rod or two from north to south, whirling *in the direction of the sun.* The motion was quite rapid, and the whirl increased in dimensions from below upwards. Dec. 29, 1838, 10 A. M., a snow whirl revolved *with* the sun. July 11, 1839, 10 A. M., a small sand whirl revolved in a direction

contrary to the sun's motion; moved towards the northeast. Aug. 3, 1839, several sand whirls formed in the road, moved but a short distance, yet all revolved in the *same* direction with the sun's motion. Aug. 4, 1839, another revolved in the *same* direction. May 8, 1840, a whirl revolved in the *opposite* direction. Having satisfied myself that these small whirls revolve indifferently with or against the sun, I took no further pains to record particular dates, but have since often observed them revolve in *each* direction.

In all the preceding cases, including those of Stow and Mayfield, there are two distinct motions—first the progressive motion of the meteor, and secondly its own peculiar motion; and this last may be resolved into three others, viz. a vertical motion, and two horizontal, one in the direction of a radius, and the other at right angles to it. These four motions appear to bear a variable ratio to each other. The upward and centripetal motions no where disappear, yet they are seen in very unequal strength at Mayfield and Painesville; while the motion at right angles to a radius is strongly marked at Mayfield, but barely distinguishable at Stow. By pursuing the method of investigation exemplified in this article, it is believed that the peculiarities of a well marked tornado can hardly escape detection. May we not then indulge the hope that the much vexed question, whether tornadoes are whirlwinds, will soon be settled? That some tornadoes are whirlwinds certainly cannot be denied. That the motion at right angles to a radius is sometimes quite small compared with the centripetal motion, seems equally clear. That this motion in a tornado should ever become mathematically nothing, appears infinitely improbable.

I have collected below, in a tabular form, all the tornadoes in this country with respect to which I have been able to obtain any important information, and have introduced some of which I could only furnish the dates. It is hoped that those who have the means will contribute to filling these blanks.

Tornadoes in the

	Date.	Hour.	Temp.	Attendant phenomena.		Course
Natchez, Miss.,	1823 May					
Morgan, Ohio,	1823 June 19	9 1-2 P. M.	unusual heat	lightn'g	rain	East
Natchez, Miss.,	1824 May					
Maury Co., Tenn.,	1830 Mar. 30					
Shelbyville, Tenn.,	1830 May 31	midnight	sultry	lightn'g	rain in torrents, but *no* hail	East
Kingston, Miss.,	1832 May 7					
Springfield, Ohio,	1833 April 11					
N. C.,	1833 Oct. 12					
Utica, N. Y.,	1834 Aug. 14	4–5 P. M.	hot	lightn'g	rain and hail	East
Kinderhook, N. Y.,	1835 June 19	4 P. M.	84°	lightn'g	rain	N. E.
N. Brunswick, N.J.	1835 June 19	5 1-2 P. M.	82	lightn'g	rain and hail	N. 80° E.
Pine Plains, N. Y.,	1837 June 3	6 P. M.	sultry	lightn'g	rain	East
Stow, Ohio,	1837 Oct. 20	3 A. M.	75° 2 P. M. on 19th	lightn'g	rain	East
Belfast, N. Y.,	1838 July 25	P. M.	hot	lightn'g		S. of E.
Providence, R. I.,	1838 Aug. 30	4 P. M.		lightn'g	rain	E. S. E.
Maumee, Ohio,	1839 May 23			lightn'g	rain	N. E.
New Haven, Ct.,	1839 July 31	noon	76°	lightn'g	rain and hail	N. 50 E.
Mobile, Ala.,	1840 Mar. 24	7 P. M.	sultry	lightn'g	rain and hail 1 inch	S. 80 E.
Natchez, Miss.,	1840 May 7	2 P. M.	80°	lightn'g	rain 8 2-3 in.: very large hailstones	N. 60 E.
Mayfield, Ohio,	1842 Feb. 4	4 1-2 P. M.	60	lightn'g	rain and hail	N. 33 E.
Tuscaloosa, Ala.,	1842 Mar. 4	6 A. M.			copious rain	N. of E.

From the preceding table it may be inferred, 1. That no season of the year is exempt from tornadoes, but that they occur most frequently in May and June. 2. That they occur chiefly between noon and sunset. Only three out of fourteen occurred during the night; and 3. That the temperature at the time is unusually elevated. This is a generalization of considerable importance, that tornadoes are to be expected only at high temperatures, and if they occur in cold months, the temperature is unusually high for the season. 4. They are invariably accompanied by lightning and rain, and frequently by hail. 5. Their progress in this country is invariably eastwardly, the mean being about twelve degrees north of east. 6. Their average breadth is about one hundred and twenty rods; length fifteen miles; velocity of progress when violent about thirty miles per hour; duration of destructive violence forty five seconds. The duration of destructive violence may be computed from the breadth and velocity of the tornado, on the supposition that its base is circular; and probably this result is more to be depended upon than the estimates of observers, which are generally made under the influence of fear and likely to be exaggerated. 7. Light objects are frequently transported by the wind a distance of from three to twenty miles. 8. Very few human lives are lost by tornadoes. With the exception of the Natchez tornado, the average is but about one to a tor-

UNITED STATES.

Breadth in rods.	Length in miles	Velocity in miles p'r hour	Duration in seconds.	Light objects carried miles.	Persons killed.	Other effects.
80–100	2			board 2 1-2		cloud of the color of a glowing [oven.
			15	shingles 3 book 7	5	cloud permanently luminous, and of the color of red hot iron.
not ov'r 320						
30–80				1-4 mile		
40–80	17 1-2	27	25 computed	reticle 7 letter 20		leeward roofs taken, Raritan [dried.
70–320	about 30			23	0	
40–80	3			sheet 3 frock 5	4	leeward roofs taken, fowls deplumed.
240–480	20				0	Genesee dried.
20–25	7	8–10	25 computed		0	leeward roofs taken, water rais-[ed.
60	8	40	30 estimated 17 computed	cape 3	0	fowls deplumed.
10–40	3-4				1	
160	25	30	few	sheet tin 20 window 30	48 in city 269 on riv'r	leeward roofs taken, fowls deplumed, water raised.
100–265	24	34	75 computed	clapb'rds 8	1	leeward roofs taken, fowls de-[plumed, Chagrin dried.
					1	

nado. This result is quite remarkable considered as a philosophical fact. At Natchez the loss of life was very great, but the circumstances were peculiar. Those on the river were chiefly travellers, and perished mostly, if not all, by drowning. The population of the city is 4800, that is, $\frac{1}{100}$th of the permanent population included within the limits of the track were killed. This is probably not greatly above the average, and it is certainly remarkable that ninety nine in a hundred of those on dry land should survive. 9. Leeward roofs are generally taken in preference to windward. 10. Fowls are frequently picked of most of their feathers. 11. In passing over ponds or rivers, water is invariably raised in considerable quantity. This last remark is sufficient to show that water-spouts and tornadoes are essentially the same.

The tornado at Morgan in 1823, is thus described by Deacon Beach. About eight o'clock, the sky became overcast with a dark cloud, attended with plentiful rain and some lightning. The rain suddenly ceased, but the cloud remained, covering the whole heavens and producing intense darkness. The air was perfectly still after the rain for about an hour, and the heat unusually great. At half past nine he heard a roaring as of very heavy thunder, which called him to the door. Upon opening it, he immediately discovered a bright cloud, having precisely the color of a glowing oven, apparently of the size of a half acre of ground, *lower* than

the dark canopy which remained unbroken above, apparently within two or three miles, and moving rapidly in the direction of his house. The brightness of the cloud made the face of things light above the brightness of a full moon. Having turned into the house, he was engaged in securing it, when the tornado passed, taking the roof and chamber floor, and many articles from below. It was a log house. There was neither hail nor rain during the passage of the tornado, neither flashes of lightning nor distinguishable peals of thunder, but an intense brightness of the cloud and a continual and tremendous roar. The passage of the tornado seemed instantaneous, but the light of the cloud continued for more than a quarter of an hour. Dea. B. was able to read in his Bible, which he found many rods from his house, at least *ten minutes* after the storm had passed.

Judge Griswold saw the same phenomenon. The cloud appeared to him funnel-shaped, apex downward, from which a stream of fire apparently issued.

The appearance of the cloud, as here described, corresponds very well with the account of the Shelbyville tornado, as given in this Journal, Vol. xxxi, p. 258. The cloud is said to have been permanently luminous, and of the color of red hot iron. This seems to indicate a continued flow of electricity from the clouds to the earth. The Stow hurricane is the only remaining one in the preceding list which occurred in the night, and I have not been able to learn that any one observed the appearance of the cloud.

In this article I have indulged in no speculations on the origin of the Mayfield tornado. This would require an investigation of the general phenomena of the storm which accompanied the tornado. I am collecting materials for such an investigation, as also of the storm of the 16th of the same month. I wish observations from the 1st to 6th inclusive, and also from the 14th to the 18th inclusive, for February, 1842. If any one has barometric observations for this period and will forward them to me by mail, accompanied with a complete copy of all his other meteorological observations for the same interval, they will be most gratefully received. I propose to give not only my own analysis of these storms, but also to publish the observations in such detail that any one may draw his own conclusions from them.

Fig. 5

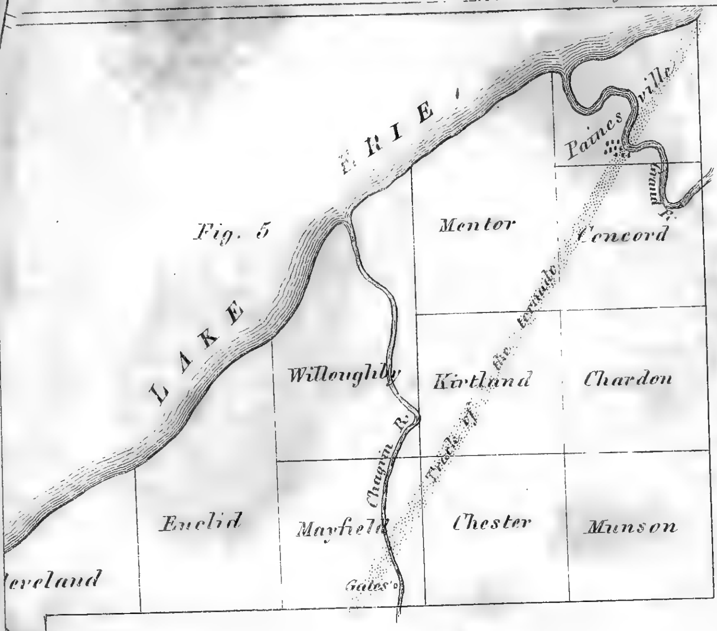


Fig 4

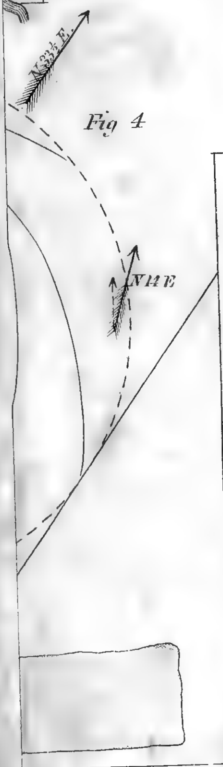
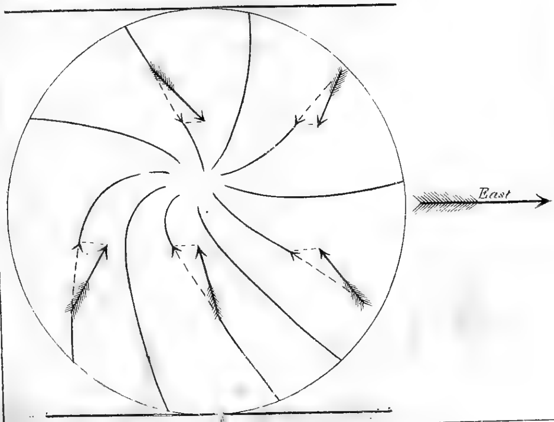


Fig. 7.



ILLUSTRATIONS TO PROF. LOOMIS'S PAPER ON THE MAYFIELD TORNADO.

Fig. 5

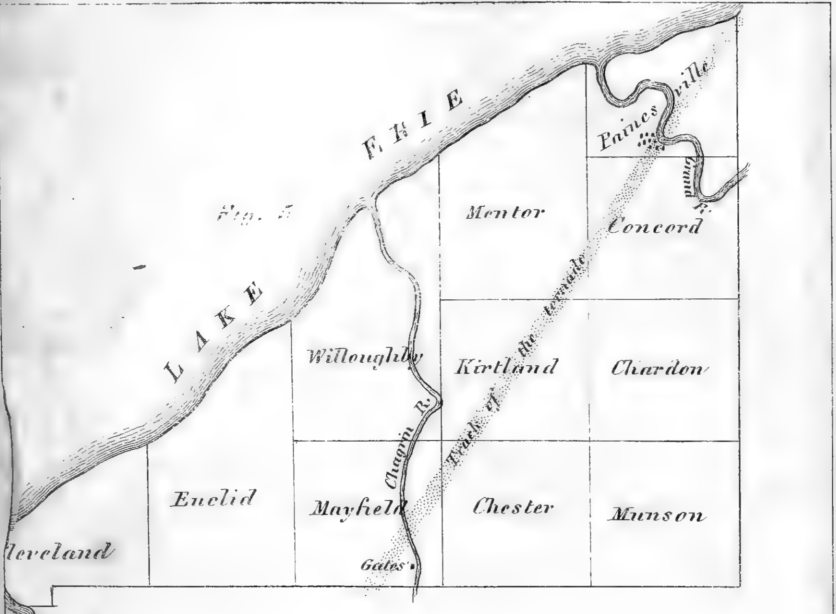


Fig 4

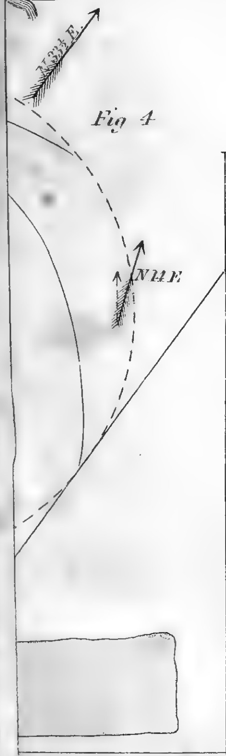
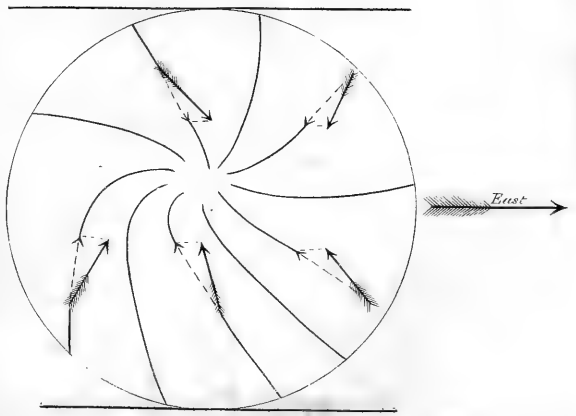


Fig. 7.



ILLUSTRATIONS TO PROF. LOOMIS'S PAPER ON THE MAYFIELD TORNADO.

ART. IV.—*The Composition and Products of Distillation of Spermaceti, with some few remarks upon its oxidation by Nitric Acid;* by J. LAWRENCE SMITH, M. D. of Charleston, S. C.*

OF all the fatty bodies that have been examined, there is perhaps no one, whose composition has been so imperfectly arrived at as that of spermaceti, and it is a little remarkable that Chevreul, with the accuracy which distinguishes his researches upon the fats, should not have ascertained more nearly its true composition.

Chevreul made the examination of spermaceti in the same way as he did that of other fatty bodies, by digesting it with a solution of an alkali, and examining the products that combined with the alkali, and those that did not. In the case of *spermaceti* he obtained a solid substance that did not combine with either *soda* or *potash,* resembling strongly in its external characters the fats, and upon analysis with bioxide of copper gave

Carbon, - - - - - -	79.76
Hydrogen, - - - - -	13.95
Oxygen, - - - - - -	6.29
	100.00

From this he calculated its formula ($C_{32}H_{33}O+HO$), and this substance he called, from some peculiarities in its composition, when compared with that of alcohol and of ether, *athal,* or rather hydrated athal.

That part of the spermaceti which combined with the potash, Chevreul considered to be composed of margaric and oleic acids, without apparently any strong grounds for so doing; he gives us no analyses of these acids, and the following is all that is said concerning them.

"The margaric acid of spermaceti is fusible at from 131° to 132° Fah., crystallizes in little radiating needles, is insipid and inodorous; at 140° Fah. it dissolves in all proportions in alcohol of .820, the solution reddening strongly litmus.

"I treated the margarate of potash with alcohol to see if I could obtain margaric acid fusible at 140° Fah. I submitted a portion of the same salt to five successive treatments, and obtained first

* Communicated by the author to this Journal.

a portion of the salt, whose acid was fusible at 113° Fah., and secondly a portion whose acid was fusible at 132° Fah.; this last portion, treated again six times with alcohol, gave first an acid fusible at 131° Fah., and secondly an acid fusible at 122° Fah.; from this I conclude that it is margaric and not stearic acid which manifests itself in the saponification of spermaceti."

Chevreul gives the following analyses of the salts of this acid, to which I have affixed the atomic weight of the acid that each indicates, and which differ considerably one from the other.

Salt.			Atomic weight of acid.
Potash salt,	Acid,	100.0	265.12
	Base,	9.8	
Baryta salt,	Acid,	100.0	275.36
	Base,	27.8	
Strontia salt,	Acid,	100.00	255.52
	Base,	20.26	
Lead salt bibasic,	Acid,	100.00	262.40
	Base,	85.00	

What was considered to be oleic acid, could not be entirely separated from the supposed margaric acid, and consequently it was impossible for Chevreul to study accurately its properties.

The elementary analysis of spermaceti according to Chevreul is

Carbon,	81.66
Hydrogen,	12.86
Oxygen,	5.48
	100.00

Dumas and Peligot, considering the base of spermaceti to be athal, and its acids margaric and oleic, have proposed the following formula.

Spermaceti.	2 ats. margarate of athal.	2 ats. margaric acid,	$(C_{34}H_{32}O_3)2$	$C_{208}H_{205}O_{14}$ *
		2 ats. athal,	$(C_{32}H_{33}O\ )2$	
	2 ats. oleate of athal.	1 at. oleic acid,	$(C_{44}H_{39}O_4)$	
		1 at. athal,	$(C_{32}H_{33}O\ )$	
		1 at. water,	$(\ \ H\ \ O\ )$	

The athal here mentioned as the base, is now considered as composed of a substance called *cetyl* or *ceten*, and water. This cetyl or ceten is obtained from athal by the action of anhydrous phosphoric acid; it is a substance of an oily nature, and consists of equal equivalents of carbon and hydrogen.

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* The formula for margaric and oleic acids are those that have lately been given by Varrentrapp.

1 at. ceten, - - - - - -	$C_{32}H_{32}$
1 at. water, - - - - - -	$H\ O$
1 at. anhydrous athal, - - -	$C_{32}H_{33}O$
1 at. water, - - - - - -	$H\ O$
1 at. hydrated athal, - - - - -	$C_{32}H_{34}O_2$

Taking ceten as being the probable base of spermaceti, Dumas has also proposed the following formula.

Spermaceti.	2 at. margarate of ceten.	2 at. margaric acid,	$(C_{34}H_{33}O_3)$	$C_{208}H_{204}O_{13}$
		2 at. ceten,	$(C_{32}H_{32}\ )$	
		2 at. water,	$(\ H\ O\ )$	
	1 at. oleate of ceten.	1 at. oleic acid,	$(C_{44}H_{39}O_4)$	
		1 at. ceten,	$(C_{32}H_{32}\ )$	
		1 at. water,	$(\ H\ O\ )$	

But it will be seen that neither the per-centage indicated by this, nor by the last formula, agrees with Chevreul's analysis of spermaceti.

208 atoms	Carbon,	1272*	80.06			
205 "	Hydrogen,	205	12.90			
14 "	Oxygen,	112	7.04		*Analysis of Spermaceti by Chevreul.*	
		1589	100.00		Carbon,	81.66
					Hydrogen,	12.86
208 atoms	Carbon,	1272	80.51		Oxygen,	5.48
204 "	Hydrogen,	204	12.95			
13 "	Oxygen,	104	6.54			100.00
		1580	100.00			

What has been stated thus far, is a short account of all that was known concerning the nature and composition of spermaceti, previous to my attention being attracted to this subject, and what follows is a detail of my investigations.

Having undertaken some time since, at the suggestion of Prof. Liebig, to examine the products afforded by the distillation of spermaceti, I arrived at certain results, which lead me to believe that the composition of this body was not properly made out, and therefore I undertook an examination of it, after the most recent methods for the investigation of fatty bodies.

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* The atomic weight here taken for carbon is that of Berzelius, (6115,) as Chevreul's calculation is made with the same.

The examination was directed to two points in particular; first, to the ascertaining whether *spermaceti contained oleic acid;* and secondly, whether *the solid acid obtained by Chevreul in his researches upon this body was margaric acid.*

The *saponification of the spermaceti* being the first step necessary in this examination, it was of some importance to make use of that method which would bring about the change the most easily. Chevreul digested the spermaceti with a strong solution of potash for a number of days to effect this change; but Dumas, in speaking of the easiest manner of obtaining athal from it, recommends that it should be saponified by fusing it with one half its weight of potash, and as by this latter means the process is completed in about one hour, it seemed to me the most preferable and was consequently adopted.

Two ounces of spermaceti was fused with one half its weight of powdered potash, care being taken that the temperature did not rise above 230° Fah.; the mass soon became solid, it was then allowed to cool, and afterwards treated with boiling water, which dissolved that portion of it which consisted of the acids, arising from the saponification in combination with potash, the other portion, consisting of athal and undecomposed spermaceti, was held in suspension. To the fused mass, treated as just mentioned with boiling water, was added hydrochloric acid, which decomposed the soap in solution and liberated the acid which it contained, and this acid being fusible at a temperature much below that of boiling water, melted and arose to the surface along with the athal and undecomposed spermaceti. This mixture upon cooling was again fused with pulverized potash, for the purpose of acting upon that part of the spermaceti which was not yet decomposed. After this second fusion it was again dissolved in hot water, which solution, holding athal in suspension, was treated with a solution of chloride of calcium, and by double decomposition a combination of the acids resulting from the saponification of spermaciti and lime was obtained, which though was mixed with athal.

The water was filtered away from the mixture of the lime salt and athal, and the mass being dried, was treated with warm alcohol of .820, which dissolved the athal, and by repeatedly washing the lime salt upon a filter with warm alcohol, and lastly with ether, until the liquid that passed through gave upon evap-

oration no residue, it was obtained perfectly free from athal. By this process a small portion of the lime salt is dissolved, which can subsequently be obtained by treating the athal, from which the alcohol has been evaporated, with ether, which leaves undissolved the lime salt, and this is added to what remains upon the filter.

The lime salt was dried, and decomposed by dilute hydrochloric acid, which furnished me with the acids arising from the saponification, and like most of the fat acids it floats about the water in flakes, which melt and collect at the surface, if the water be heated.

Having now the acids free from undecomposed spermaceti and athal, the first part of the examination, that is to say, the examination for oleic acid, was carried on as follows.

Examination for oleic acid in spermaceti.—A portion of the acid was digested with water and the protoxide of lead, at a temperature of 212° Fah., and in the course of a short time a lead salt was formed, which after being perfectly dried, was treated with cold ether, that dissolved no portion of the salt, a circumstance that could not have occurred, had the oleate of lead been present, as this salt is soluble in ether, and it is one of the means used to separate oleic acid from other fatty acids.

The above is the most direct way that we have of deciding upon the presence of oleic acid, and the indication which it affords in the present case, was of too positive a character, to admit for a moment the existence of this acid in the substance examined. But this single evidence, although sufficient of itself, has other indirect proofs to support it.

Redenbacker,* in his examination of the products of the distillation of oleic acid, observed the fact, that if this acid, or any substance containing it, be distilled, that sebacic acid is invariably formed. To this test spermaceti has been subjected by both Redenbacker and myself, with similar results, that is to say, that in the products afforded by the distillation of spermaceti, no trace of sebacic acid is to be found.

The products furnished by the oxidation of spermaceti by nitric acid, is another proof of the non-existence of oleic acid in this

* Redenbacker properly speaking was the first to generalize this fact, for it has been a long while since it was observed.

substance. Laurent and subsequently Bromeis have shown, that when oleic acid is oxidized by nitric acid, that suberic acid is one of the most abundant products of this decomposition. Now if spermaceti be oxidized by nitric acid no trace of suberic acid is furnished.

Having then the support of both direct and indirect evidence, I do not hesitate to affirm that *spermaceti contains no oleic acid.*

A question necessarily arising from this fact was, what was the acid that Chevreul had taken for oleic acid? To decide this the following steps were taken. That portion of the acid obtained from the lime salt, which had not been digested with the oxide of lead, was treated with carbonate of soda, this forming a soda salt, which being dissolved in hot water, was decomposed by tartaric acid. The fat acid, thus liberated from the soda, was dissolved in warm alcohol, and upon allowing the solution to cool, a considerable quantity of the acid crystallized out. The alcohol was poured off of this crystalline deposit, and concentrated by evaporation, from which another portion of the acid was allowed to crystallize. The alcohol was decanted a second time, concentrated and allowed to cool, and by repeating this four or five times, and at last evaporating all the alcohol away, there was left a small quantity of a solid fatty mass, which evidently still contained a considerable portion of the same acid that had been crystallized from the alcoholic solution. This acid had a melting point of 68° F. and consisted of a mixture of a fluid and solid acid, but it was impossible to obtain the former, in a state of purity, and as consequently no accurate examination of it could be made, none was undertaken.

The fluid acid that composed a portion of this mass, was in too inconsiderable a quantity, to be considered an essential constituent of spermaceti, particularly too as its presence can be plausibly accounted for. Spermaceti, as it exists in nature, is mixed with an oil, from which it is separated by pressure for domestic use; now it is impossible that by simple pressure we should be able to deprive the spermaceti completely of this oil, but in Chevreul's analysis, as well as in mine, the spermaceti of commerce was treated with hot alcohol of .820; still there are many reasons for supposing that even by this means it is impossible to extract all the oil; either from the fact that the oil is not more soluble in alcohol than the spermaceti, or that the attraction

that the oil and spermaceti have for one another, is too strong to be overcome by this means. Of the truth of this latter supposition we have many similar examples, particularly among the fats, a circumstance which renders their examination to the present day incomplete and imperfect. At some future time my attention will be directed to the examination of spermaceti prepared in a different manner from that pursued in the present case, particularly with the object of ascertaining whether spermaceti cannot be so purified as that its saponification will give rise to no fluid acid.

Thus, then, as regards the existence of a fluid acid in spermaceti, all that can be said is, that from the small quantity found, and from other reasons just stated, there are strong reasons for believing that it contains none, and that what has been found is due to an impurity which is not removed by alcohol of .820.

Solid Acid resulting from the Saponification of Spermaceti.—I come now to the second part of the examination, and by far the most interesting; that of the solid acid obtained from the saponification of spermaceti, for it is this and athal that are the essential products resulting from the action of potash upon spermaceti.

The solid acid obtained in that part of the examination which was directed to ascertaining the presence of a fluid acid in spermaceti, and which was crystallized out of alcohol, was found to be nearly in a state of purity. This was dissolved in a mixture of equal parts of alcohol and ether, and allowed to crystallize out. This operation was repeated two or three times, and the crystalline deposit was then thrown upon a filter and washed with cold alcohol of .820. The acid thus obtained was pure, and possessed the following properties.

It melted at 130° F., and upon cooling crystallized in small needles, diverging from a number of centres, and when cool is white; it resembles somewhat in appearance wax, it being slightly translucent. It was dissolved in all proportions by alcohol of .820 at 140° F., and upon cooling crystallized out in small needles, which collected together in the form of moss, and sometimes in that of cauliflower; from this, the alcohol can be poured so as to leave it almost perfectly dry. Out of ether this acid crystallized with difficulty, owing to its excessive solubility in this menstruum. When heated to a high degree, it volatilizes without leaving a residue. The alcoholic solution reddens litmus.

The physical properties of this acid will be seen to differ from those of margaric acid, which it has been supposed to be, but there is no striking difference between these two bodies in composition, as will be seen in the results afforded by the analysis of this body.

Exp. 1. 0.2815 grammes of the acid burnt with the bioxide of copper gave* 0.7725 gram. carbonic acid and 0.320 gram. water.

Exp. 2. 0.2325 gram. of the acid burnt with the bioxide of copper gave 0.637 gram. carbonic acid and 0.261 gram. water.

Exp. 3. 0.328 gram. of the acid burnt with the chromate of lead gave 0.890 gram. carbonic acid and 0.3685 gram. water.

These three analyses furnish the following proportions of carbon, hydrogen, and oxygen, in 100 parts of the acid.

Carbon,	75.44	75.31	74.64	75.13†
Hydrogen,	12.60	12.47	12.46	12.51
Oxygen,	12.96	12.22	12.90	12.36
	100.00	100.00	100.00	100.00

Having thus found the relative proportions of the elements contained in this acid, it was necessary to examine one of its salts, to ascertain its atomic composition, and for this purpose, as in most cases, its combination with the oxide of silver was chosen, but to form this salt it was necessary first to form its soda salt.

Soda Salt.—A portion of the acid was digested with a solution of carbonate of soda, until a complete combination had taken place, which is easily known by the acid no longer floating on its surface, it having all united with the soda, forming a salt soluble in water. The solution of this salt, which contained an excess of carbonate of soda, was evaporated to dryness in a water bath, and the dry mass, pulverized, was treated with absolute

* All my calculations are made with the atomic weight of carbon given by Liebig and Redenbacker, (75.85 oxygen being considered 100, or 6.068 hydrogen being taken as unity.)

† Composition of margaric acid after the analysis of Varrentrapp—

Carbon,	75.35
Hydrogen,	12.33
Oxygen,	12.32
	100.00

alcohol, which dissolved the soda salt and not the carbonate of soda; from this the alcoholic solution was separated by filtration, and this last, evaporated to dryness, furnished the salt perfectly pure.

Silver Salt.—This salt was formed by a double decomposition of the salt just described and nitrate of silver. The soda was dissolved in water, and to this was added a solution of nitrate of silver, which produced a white flocculent precipitate, the salt in question. This precipitate was thrown on a filter and well washed with warm distilled water, and dried at 212° in the dark.

This silver salt, when burnt in a porcelain crucible, gave the following results.

Exp. 1.	0.332 gram.	silver salt	gave	0.098 gram.	silver.
" 2.	0.389 "	"	"	0.117 "	"
" 3.	0.5765 "	"	"	0.1705 "	"

Out of these the following per centage of silver and oxide of silver in the salt was calculated.

Exp. 1.	29.56 silver,	31.75 oxide of	silver.
" 2.	29.39 "	31.57 "	"
" 3.	29.59 "	31.77 "	"

From the same analyses the atomic weight of the anhydrous acid was calculated to be, from

Exp. 1.	250.00		
" 2.	251.52	Mean, . . .	250.24
" 3.	249.36		

The silver salt was now analyzed with bioxide of copper, to ascertain the quantity of carbon and hydrogen that it contained.

1. 0.4735 gram. silver salt burnt with the bioxide of copper, gave 0.910 gram. carbonic acid, and 0.3595 gram. water.

2. 0.483 gram. silver salt burnt with the bioxide of copper, gave 0.934 gram. carbonic acid and 0.3705 gram. water.

From these analyses we find in 100 parts of the salt—

	1.	2.	Mean.
Carbon, .	52.84	53.15	53.00
Hydrogen, .	8.42	8.52	8.47
Oxygen, .	7.04	6.63	6.83
Oxide of silver,	31.70	31.70	31.70
	100.00	100.00	100.00

Out of this the following formula is calculated.

Atoms.	Atomic weight.	In 100 parts. Calculated.	Found.
32 Carbon,	194.18	53.16	53.00
31 Hydrogen,	31.00	8.48	8.47
3 Oxygen,	24.00	6.57	6.83
1 Oxide of silver,	116.13	31.79	31.70
	365.31	100.00	100.00*

The anhydrous acid is constituted as follows:

Atoms.	Atomic weight.	In 100 parts.
32 Carbon, . .	194.18	77.92
31 Hydrogen, . .	31.00	12.44
3 Oxygen, . .	24.00	9.64
	249.18	100.00

The atomic weight of this acid, found by burning the silver salt, was 250.24. The acid not in combination with a base, contains one atom of water, and has for its composition—

Atoms.	Atomic weight.	In 100 parts. Calculated.	Found.
32 Carbon,	194.18	75.21	75.13
32 Hydrogen,	32.00	12.39	12.51
4 Oxygen,	32.00	12.40	12.36
	258.18	100.00	100.00

After the results afforded by these analyses, it is impossible to confound this acid with margaric acid, and particularly too, as its composition agrees with that of another acid described by Dumas and Stass, under the name of *athalic acid*, and which they obtained by acting upon *athal with potash*, at a temperature of from 390° to 410° F. The acid then which has just been described, and which was obtained from the saponification of spermaceti, is *athalic acid.*

The athal that Chevreul mentions as being the base of spermaceti, and related to it, as glycerine is to the other fats, was found to be of the same nature that he describes it to be.

	Atoms.		In 100 parts.
* Margarate of silver,	34 Carbon, . .	206.31	54.57
	33 Hydrogen, .	33.00	8.65
	3 Oxygen, . .	24.00	6.30
	1 Oxide of silver,	116.13	30.48
		379.44	100.00

Conclusion as regards the Composition of Spermaceti considered as a fat.—Before coming to this conclusion, a *résumé* will be made of the results, that have been arrived at in the different steps of this investigation. As regards *athal*, or what is considered the base of spermaceti, nothing has been brought to light to change in any way the statements made concerning its nature. *Oleic and margaric acids* have been proved not to exist in spermaceti. From the saponification of spermaceti, prepared as it was for these experiments, a small quantity of a fluid acid was obtained, but for reasons before stated, considered as an impurity. The acid product arising from the saponification of spermaceti, was found to consist almost entirely of *athalic acid.*

From these facts *spermaceti*, considered as a fat, (I make this qualification, as a little farther on it will be attempted to be shown that it is not properly speaking a fatty body,) is composed of one acid and one base, the former being *athalic acid*, and the latter *athal*, and it is therefore an *athalate of athal*, consisting of

		Atomic weight.
One atom anhydrous athalic acid,	$C_{32}H_{31}O_3$,	249.18
One atom anhydrous athal,	$C_{32}H_{33}O$,	235.18
One atom spermaceti, ...	$C_{64}H_{64}O_4$,	484.36

That this is no doubt the true composition of spermaceti, will be seen by the results afforded by the analysis of this substance, prepared by crystallizing it out of absolute alcohol.

Exp. 1. 0.306 gram. spermaceti burnt with the bioxide of copper, gave 0. 8945 gram. carbonic acid, and 0.370 gram. water.

Exp. 2. 0.2385 gram. spermaceti burnt with the bioxide of copper, gave 0.691 gram. carbonic acid, and 0.282 gram. water.

Exp. 3. 0.408 gram. spermaceti burnt with the chromate of lead, gave 1.198 gram. carbonic acid, and 0.486 gram. water.

Exp. 4. 0.314 gram. spermaceti burnt with the bioxide of copper and oxygen, gave 0.913 gram. carbonic acid, and 0.370 gram. water.

Exp. 5. 0.212 gram. spermaceti burnt with the bioxide of copper and chlorate of potash, gave 0.625 gram. carbonic acid, and 0.252 gram. water.

Comparing the per centage of carbon, hydrogen, and oxygen, afforded by these experiments, with that given by the supposed composition of spermaceti, ($C_{64}H_{64}O_4$,) we have in 100 parts

	Atoms.	Atomic wght.	Calcul.	Found. 1.	2.	3.	4.	5.
Carbon,	64	388.36	80.18	80.36	79.66	80.70	79.91	81.08
Hydrogen,	64	64.00	13.22	13.53	13.12	13.23	13.40	13.21
Oxygen,	4	32.00	6.60	6.11	7.22	6.07	6.69	5.71
		484.36	100.00	100.00	100.00	100.00	100.00	100.00

Distillation of Spermaceti.—The products furnished by the distillation of spermaceti were examined some time since by Bussy and Lecam, but they appear to have fallen into the same error with regard to them as was committed in the analysis of spermaceti, for they state that oleic and margaric acids were among the products.

To make a correct examination of the products of the distillation of spermaceti, it was necessary that the substance should be in the greatest state of purity, as the presence of the smallest quantity of tallow, sometimes used as a means of adulteration, would serve to lead one into error. The manner of purification here employed, was to dissolve the spermaceti in a mixture of two parts of alcohol of .820 and one part of ether, allowing it to crystallize out, and washing the crystals with boiling alcohol of .820.

If some of the spermaceti, purified as just mentioned, be placed in a small retort, and this last in mercury heated to its boiling point, the spermaceti will be found to distill over slowly, and in fact this appears to be the lowest temperature at which the distillation takes place—a temperature of about 600° Fah. The matter distilled no longer possesses the properties of spermaceti; its melting is at a temperature somewhat lower, and it has a strong acid reaction upon litmus paper, as well as a peculiar smell, which though is not at all that of *acroleine.**

If the products afforded by the distillation be digested with water, and this water be examined, it will be found not to possess the slightest acid reaction, a fact of considerable importance, and one that has been mentioned in a former part of this article as an evidence of the non-existence of oleic acid in spermaceti,

* If tallow be heated until it distills, it will be found to possess an odor which irritates both the nostrils and eyes, and the substance to which this odor belongs is called acroleine, and is a product of the decomposition of the glycerine in the tallow. It has been found that all bodies that contain glycerine, when heated sufficiently high, give the same odor, and it has therefore become the test for the glycerine.

oleic acid or any of its compounds always furnishing by distillation sebacic acid, an acid soluble in water. The water, moreover, will be found to have taken up nothing, it having simply acquired a slight odor, resembling that of the mass with which it was digested.

The steps taken to ascertain the nature of the products, were the following. The mass obtained from the distillation was digested with a solution of potash for an hour or two, and to this, placed in a convenient vessel, was added ether, and the two agitated together, and then allowed to repose. The ether arose to the surface, containing in solution certain products; this was drawn off, and a fresh portion added, and the agitation repeated. This operation was carried on until nothing remained that was soluble in this menstruum.

The ether was evaporated, and a residue obtained, consisting of an oily fluid holding spermaceti in solution. The separation of the oil from the spermaceti was attended with considerable difficulty, but by the aid of pressure at a very low temperature, and careful distillation, a small quantity of the oil was obtained tolerably pure.

0.222 gram. of the oil, burnt with the bioxide of copper, gave 0.688 gram. carbonic acid, and 0.282 water, and this in 100 parts gives

Carbon, - - - -	85.04
Hydrogen, - - - -	14.12
	99.16

These numbers show it to be a carburetted hydrogen, composed of equal equivalents of carbon and hydrogen, and this, together with such of its physical properties as I was able to examine, lead me to believe it to be *ceten*, the carburetted hydrogen already spoken of as the supposed base of *athal.* Considering this oil to be *ceten*, its composition is represented by

			In 100 parts.	
Atoms.		Atomic weight.	Calculated.	Found.
32	Carbon,	194.18	85.85	85.04
32	Hydrogen,	32.00	14.15	14.12
		226.18	100.00	99.16

The solution which had been treated with ether, was now perfectly transparent, and contained potash in combination with

the acid products resulting from the distillation. To this was added a solution of chloride of calcium, by which means an insoluble compound of the acids and lime was formed, and this being decomposed by hydrochloric acid, furnished the acids for examination.

Although it was evident from what had been before done, that no oleic acid could be present, yet to prevent any doubt, I made a direct examination for this acid, by digesting a portion of the acid mass with water and oxide of lead, and then treating the lead salt thus formed with ether, which dissolved no portion of it. The portion of the acid product not digested with the oxide of lead, was found to consist of a solid acid, mixed with a very small quantity of a fluid one, which I considered to be the same, that has been before mentioned, as a probable impurity of spermaceti, and for the same reasons then stated, it was impossible to make any examination of it.

The solid acid, which was obtained pure by repeated crystallization out of alcohol, exhibited the same physical properties, as well as chemical composition, as the acid obtained from the saponification of spermaceti, and which has been shown to be *athalic acid.*

0.2715 of the acid gave 0.739 gram. carbonic acid, and 0.306 gram. water, making in 100 parts

		Hydrated athalic acid.
Carbon, - - -	75.00	75.21
Hydrogen, - - -	12.52	12.39
Oxygen, - - -	12.48	12.40
	100.00	100.00

0.8625 gram. of the silver salt, when burnt, gave 0.254 gram. silver, which indicates in 100 parts, 29.44 silver, 31.61 oxide of silver, and an atomic weight of 250.

0.481 gram. of the silver salt, burnt with the oxide of copper, gave 0.932 gram. carbonic acid, and 0.368 gram. water. The per centage afforded by this will serve to show the identity between it and *athalic acid.*

			In 100 parts.	
Athalate of silver.	Atoms.	Atomic weight.	Calculated.	Found.
Carbon,	32	194.18	53.16	53.28
Hydrogen,	31	31.00	8.48	8.50
Oxygen,	3	24.00	6.57	6.61
Oxide of silver,	1	116.13	31.79	31.61
		365.31	100.00	100.00

In the distillation of spermaceti there are other products found than those just mentioned; but they appear only towards the latter end of the process, and result from an elementary decomposition; they are water, carbonic acid, carbonic oxide and gaseous carburetted hydrogen, carbon being left behind in the retort; and these products are very small in quantity, except when the vessel is very deep and the heat strong.

If proper care be taken, spermaceti can be distilled almost completely, there being left behind an exceedingly small black residue. A circumstance which facilitates this complete distillation is, having kept the spermaceti for some time at the temperature of about 550° to 600° Fah.

The results of the investigations upon the distillation are, first, that it is impossible to distill spermaceti, without more or less of it undergoing decomposition; and secondly, that the products of this decomposition are *ceten* and *athalic acid*, which fact serves to substantiate the correctness of the formula already taken for spermaceti, thus—

One atom ceten, - - -	$C_{32}H_{32}$
One atom hydrated athalic acid, -	$C_{32}H_{32}O_4$
One atom of spermaceti, - -	$C_{64}H_{64}O_4$

Nature of Spermaceti.

From the foregoing researches, I feel somewhat prepared to speculate upon the true nature of spermaceti, for although it may be difficult to arrive at any positive conclusion with regard to it, still we should not be deterred from forming a judgment upon probabilities.

For many reasons, spermaceti would appear not properly to belong to the class of fatty bodies, and consequently not composed of an acid and a base. The fats properly speaking are known to be composed of acids, more or less different in their nature, in combination with glycerine; and when Chevreul found athal, as in spermaceti, accompanied with an acid, he considered athal as the base in this case, as well as making it the great mark of distinction between spermaceti and the fats.

Before going on to state the reasons why spermaceti should not be considered a fat, it would be well to mention what I suppose to be its proper position among the organic bodies. *Sper-*

maceti ought properly to be classed with *cholesterine* and *athal*, although approaching nearer to the fats than either of these substances; and that both the athalic acid and athal resulting from the saponification, are simply products of decomposition, brought about by the action of an alkali, neither of them existing ready formed.

The first reason for so believing, is based upon the extreme difficulty with which spermaceti is saponified, it requiring to be digested for a number of days in a strong solution of potash or soda, or to be fused with the same alkalies at a temperature of from 212° to 220° Fah. before this change takes place. Now from the experiments of Dumas and others, it will be seen that the action of hydrated potash upon organic substances, at a temperature more or less elevated, is to decompose them, by changing their molecular arrangement, and that among the products formed, acids play the most conspicuous part; the atom of water in the alkali is often important in bringing about this change, by furnishing oxygen, hydrogen gas being evolved; but the action of this water appears to be but a secondary thing, and its influence is only felt where oxygen does not exist in sufficient quantity in the substance acted upon by the alkali, to furnish the products that are found with the quantity that they exact.

The above would appear to apply exactly to the case in question. The spermaceti contains oxygen enough, which when combined with one half of its other elements, serves to give rise to an acid; it is quite possible that the action of the alkali, although not sufficiently strong at the temperature of 212° Fah. to determine the elements of the spermaceti, to appropriate the atom of water in the alkali to its complete conversion into *athalic acid;* (I say complete conversion into athalic acid, for it will be shown that the action of an alkali at a high temperature is to convert spermaceti entirely into *athalic acid;*) still it is of sufficient energy to disturb its atomic arrangement, most of its oxygen combining with one half of the other elements, to form an acid which unites with the potash.

It may be said, that if this explanation of the saponification of spermaceti be true, we should apply the same to the saponification of all fats, no longer considering them composed of acids and glycerine, but simply of carbon, hydrogen, and oxygen, in the proper proportions to form them. But there appears to me

no necessity for forming such a conclusion, as the circumstances attending the saponification of spermaceti and that of the fats differ considerably, and if this difference be taken into consideration with what follows, there is no doubt that the justice of this explanation will be seen.

Another reason for supposing that spermaceti does not consist of an acid and a base, or rather that athal does not exist in it ready formed is, that in the products afforded by the distillation of spermaceti, no trace of athal is to be found. This fact is one that should be considered of great value in establishing the nature of spermaceti, for there is no way of explaining the non-existence of athal among the products of the distillation, except by admitting that the substance distilled did not contain it, for athal is a body easily volatilized without decomposition.

If, on the contrary, we remark the action of a strong solution of potash upon spermaceti at 100°, we find athal to be volatilized during the process, an evidence of the ease with which this substance is volatilized, as well as the necessity of an alkali for its formation.

Let us compare with this the action of heat upon the fats, with reference to the change that the glycerine undergoes. We find that if a fat be distilled, a portion of the glycerine is decomposed, giving rise to acroleine, (a mixture of acetic acid, &c.) and another portion passes over undecomposed; this is also exactly what takes place if glycerine be distilled alone, whereas in the distillation of spermaceti, its athal (supposing it to contain it) undergoes *complete decomposition*, although athal, distilled by itself, does not undergo *the least decomposition*.

This second reason then serves to increase the difference between the nature of spermaceti and that of the fats, but I am able to advance another fact stronger than either of the above, augmenting this difference.

Dumas and Stass have shown, that if athal be acted upon by potash at a temperature of from 410° to 428° Fah. an acid is the result, which acid they called *athalic acid*, the same that has been shown to result from the saponification of spermaceti, where the same alkali was employed, but at a much lower temperature. The action then of potash upon spermaceti, assisted by the proper temperatures, is to produce but one body, *athalic acid*, which circumstance would hardly take place were spermaceti composed

of two or more proximate principles. We have no similar example among the fats.

Although cholesterine does not undergo any change by the action of a solution of potash at 212° Fah., still the analogy between it and the spermaceti may exist, for it must be observed that cholesterine, having an atomic weight of more than one half that of spermaceti, contains only one atom of oxygen, and not sufficient to give rise to an acid without the aid of an additional quantity, and it is probable that if cholesterine be treated with an alkali at a high temperature, that an acid similar to athalic acid would be the result, for then oxygen would be furnished from the water of the hydrated alkali.

For the above reasons, spermaceti should be considered a simple organic substance, having, as already shown, for its composition, $C_{64}H_{64}O_4$. The action of an alkali upon it, produces a decomposition, which may be represented thus—

Anhydrous athalic acid in combination with the alkali,	$C_{32}H_{31}O_3$
And hydrated athal, its atom of water being obtained from the alkali in combination with the athalic acid,	$C_{32}H_{33}O + HO$
Spermaceti, plus one atom of water,	$C_{64}H_{64}O_4 + HO$

Under the head of the distillation of spermaceti, the decomposition brought about by the action of heat was shown to be represented thus—

Hydrated athalic acid, - -	$C_{32}H_{32}O_4$
Ceten, - - - - -	$C_{32}H_{32}$
Spermaceti, - - - -	$C_{64}H_{64}O_4$

Oxidation of Spermaceti.

Having made mention of the oxidation of spermaceti, as one of the evidences of the non-existence of oleic acid in this substance, I shall give a short statement of what has been done under this head, although but little, owing to the difficulty of isolating the products that are formed.

When nitric acid and spermaceti are heated together, a gentle action takes place, and nitrous acid fumes are given off; at the end of three or four days, the spermaceti still floats upon the surface of the acid, but considerably changed in its nature, having

nearly the consistency of hog's lard, and an odor of rancid butter, owing probably to the presence of phocenic or butyric acid, but I am more inclined to believe phocenic acid, as this acid is found in the oil in connection with which spermaceti is found in its natural state, and the spermaceti may no doubt play some part in its formation; this fact is interesting, and worthy of future examination.

The action of the acid being continued, (renewing it as it evaporates,) in about ten days the spermaceti is in complete solution when the liquid is hot, and at the expiration of eighteen or twenty days the oxidation is completed, and if the solution be concentrated, a crystalline deposit takes place.

The examination of the products formed is as yet imperfect: the following is all that has been done, that can be relied upon as accurate.

After the completion of the oxidation, the mass was thrown upon a funnel, containing in its neck a bit of asbestus; the fluid was thus separated from the crystalline deposit, which was washed with strong nitric acid. The fluid that passed through, upon concentration, furnished more of the same crystals.

The crystalline mass in the funnel gave, upon examination, no traces of suberic acid, but when dissolved in warm water and allowed to cool, a deposit slowly took place, having the form of little grains, and the appearance of starch. Its reaction is strongly acid, and when crystallized several times from its aqueous solution, and dried at 212° Fah., it has a melting point of 298° Fah. It sublimes easily in feather-formed crystals; its ammoniacal salt does not precipitate the chlorides of lime, of baryta or of strontia, the sulphate of copper, sulphate of zinc, or neutral acetate of lead. With the basic acetate of lead a precipitate is formed, which is soluble in an excess of the lead salt.

0.3645 gram. of this acid, burned with the bioxide of copper, gave 0.666 carbonic acid, and 0.230 water: in 100 parts—

Carbon, - - - -	50.20
Hydrogen, - - - -	7.00
Oxygen, - - - -	42.80
	100.00

The silver salt is easily formed by double decomposition with the ammoniacal salt and nitrate of silver. It is slightly soluble in water, and not easily altered by the action of light.

Exp. 1. 0.525 gram. of this salt when burnt gave 0.294 gram. silver.

Exp. 2. 0.612 gram. of this salt when burnt gave 0.343 gram. silver.

These give in 100 parts—

1. 56.01 silver, or 60.00 oxide of silver.
2. 56.05 " 60.19 " "

Burnt with the bioxide of copper:

Exp. 1. 0.708 gram. silver salt gave 0.582 gram. carbonic acid, and 0.174 gram. water.

Exp. 2. 0.787 gram. of silver salt gave 0.6465 gram. carbonic acid, and 0.190 gram. water.

These experiments give the following per centage.

	1.	2.	Mean.
Carbon,	22.56	22.60	22.58
Hydrogen,	2.68	2.68	2.68
Oxygen,	14.67	14.63	14.65
Oxide of silver,	60.09	60.09	60.09
	100.00	100.00	100.00

Out of this, the following formula of a bibasic salt is calculated.

	Atomic weight.	In 100 parts. Calculated.	Found.
14 ats. Carbon,	84.95	22.18	22.58
10 " Hydrogen,	10.00	2.66	2.68
7 " Oxygen,	56.00	14.65	14.65
2 " Oxide of silver,	232.25	60.51	60.09
	383.20	100.00	100.00

This formula agrees with that of adipinate of silver, as made out by Bromeis, with the unimportant difference of one atom of hydrogen, and its physical properties and reactions are the same as adipinic acid: I consider it as such.

None of the other acids afforded by the oxidation of spermaceti, have been obtained in state of sufficient purity to be examined. There is however one among them, whose copper and zinc salts are more soluble in cold than in warm water, and if a solution of either of them be heated a precipitate is formed, which redissolves upon cooling; this phenomenon is most striking in the zinc salt. Those portions of the examination of this subject that are as yet incomplete, I propose finishing at some future time.

Paris, April 29, 1842.

Art. V.—*Sketch of the Infusoria of the family Bacillaria;* by J. W. Bailey, Professor of Chemistry, &c. in the U. S. Military Academy.

Part III.

The animalcules which form the subject of this part of my sketch of American Bacillaria, belong to the sections Echinellea and Lacernata.

The section Echinellea contains those Bacillaria which are *fixed,* that is, attached either by their extremities, or by a pedicel, to other bodies. They are all siliceous.

The section Lacernata includes those which have a double covering. They consist of groups of siliceous individuals, surrounded by a common gelatinous mass, or enveloped by a membranous tube.

As many species of each of these sections are often found spontaneously or accidentally separated from their pedicels or tubes, there is great chance of mistaking them for species of Naviculacea.

Sect. III. ECHINELLEA.

Isthmia.

Fixed by one end, carapace or lorica siliceous, simple, broader than long, catenate by imperfect spontaneous division, individuals making various angles with each other, and connected by a narrow isthmus or neck-like process.

Two species of this genus have been detected, viz. *I. enervis,* and *I. obliquata.* Neither of these have, to my knowledge, yet been detected in the United States; but as the latter is a pelagic species which has been found in places so different and distant from each other as Iceland, England, the Canary Islands, Cape of Good Hope, &c. there can be little doubt that it will yet be found growing on some of our marine Algæ. The first specimen which I ever saw, I detected on a dry specimen of Odonthalia dentata from Iceland. I have since received fine English specimens from E. J. Quekett, Esq. of London. Few microscopic objects exceed in beauty these little gems of the ocean. I have proved that their carapace is siliceous by the proper chemical

tests. A good idea of the general form of this genus may be got from Plate 4, fig. 153, of Pritchard's Infusoria.

Synedra.

Carapace simple, siliceous, fixed when young by one extremity, when older often free, longer than broad, foot either wanting or rudimentary, form elongated or prismatic.

Synedra ——? (Pl. 3, fig. 1.)* Frustules long, slender, linear, adhering laterally into plates which are supported by a short fleshy pedicel, and terminated by a fleshy mass.

The species whose usual appearance is shown in Pl. 3, fig. 1, occurs in vast quantities on various Algæ in the Hudson River at West Point. It usually completely envelopes the plants to which it is attached, giving them a covering of bristling crystal-like particles, through which it is often difficult to see any portion of the supporting plant. When the Algæ on which it grows are dried, they often have a greenish gray hue, from the presence of this parasite.

It presents considerable resemblance to S. Gailloni, Ehr. (Diatoma crystallinum, Ag.) and has, like that, minute striæ on the edges, but I have seen no allusion made in the descriptions of that species to the fleshy projection which is so conspicuous in our species.

A person who sees how abundant this species is in the recent state, will no longer wonder that in the lapse of years masses of infusorial shells should accumulate so as to form extensive strata.

Synedra ——? (Pl. 3, fig. 2.) Frustules linear, strait, striate, truncate on the lateral side, ventral sides with a neck-like contraction near each end, ends rounded.

This species is very abundant in fresh water near West Point, often covering aquatic plants with a glittering envelope of crystal-like frustules. The individuals are perfectly linear with truncate ends. When seen laterally, they show near their extremities a slight contraction, which forms a neck supporting the round or knob-like terminations. Minute striæ may be seen as represented in the figure.

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* Plate III, which accompanies this part of Prof. Bailey's article, is also marked V in the series of plates contained in the present volume of this Journal. Plate III is marked at the bottom and plate V at the top of the plate.—Eds.

This species presents many points of resemblance both to Synedra ulna and Fragillaria rhabdosoma of Ehrenberg, but I cannot identify it positively with either.

Podosphenia.

Carapace simple, siliceous, cuneiform, fixed when young by one end, afterwards often free, longer than broad, pedicel small, hemispherical, or wanting.

In Pl. 3, fig. 3, is represented a species which agrees with the above generic characters, and which I therefore place here, although it is a fluviatile production, while all of Ehrenberg's species are marine. It invests stones, &c. in small streams near West Point with a yellowish green covering, which appears like a mere stain, but which when scraped off with a knife, is seen to be composed of excessively minute frustules resembling those of Gomphonema, but which have no perceptible pedicel.

Gomphonema.

Carapace simple, siliceous, cuneiform, fixed upon a distinct filiform branching pedicel, dichotomous by spontaneous division.

1. *Gomphonema minutissimum.* (Pl. 3, fig. 4.) Smooth? corpuscles cuneiform, curved, clavate, $\frac{1}{144}$ to $\frac{1}{72}$ line.

A minute species agreeing closely with Kutzing's figure of G. minutissimum, (see Linnea, 1833, fig. 43,) occurs abundantly on various aquatic plants in the Hudson River at West Point. It varies much in size; fig. 4, *a*, shows the largest individuals, and fig. 4, *b*, the smaller ones.

2. *Gomphonema* ——. (Pl. 3, fig. 5, *a*, *b*.) This large and beautiful species appears to be related to G. dichotomum and to G. geminatum, but I am unable to satisfy myself of its identity with either. I found it in vast quantities at the Island of Mackinaw, Straits of Michillimackinac, on a large cedar tree which was sunk in water ten or fifteen feet deep, and which was literally covered with large waving bunches of a yellowish white color, composed of the dichotomous filaments of this species, glittering with crystal-like particles.

The individuals are striate, with one side cuneate, and showing at the broad end two interior arcuate folds; the other side is elongated, obovate or clavate, with a central circular spot and longitudinal smooth portion. The pedicel is repeatedly dichotomous.

3. *Gomphonema acuminatum?* (Pl. 3, fig. 6.) Striate, corpuscles elongated, wedgeform, end swollen and pointed, contracted on the side.

The small species (fig. 6) agrees pretty well with the above characters. It is common in ponds near West Point. I have also seen it in several American specimens of fossil infusoria.

4. *Gomphonema* ——. (Pl. 3, fig. 7.) Frustules smooth, geminate or in fan-shaped groups, one side elongated, wedge-shaped, truncate; the other side obovate; pedicel repeatedly dichotomous. Marine.

I have examined this species only in a dry state, having first noticed it on a glass slide on which I had preserved some specimens of Echinella flabellata from Stonington, Conn.

The figure is drawn from the dry specimens.

Echinella, *Ehr.*

Carapace simple, siliceous, fixed at one extremity to a pedicel, wedgeform, longer than broad, fan-shaped or verticillate by spontaneous division.

1. *Echinella flabellata.* (Pl. 3, fig. 8.) Smooth, corpuscles linear, cuneiform, truncate, slightly three-toothed, striæ longitudinal, $\frac{1}{10}$ line without the pedicel. *Licmophora flabellata, Ag.* Greville in Hooker's English Flora, V, p. 408.

This beautiful marine production presents in its fan-shaped groups of crystal-like corpuscles, an exceedingly elegant appearance. The fans are supported by long flexible clavate pedicels, which are grouped together in large bunches covering filamentous marine Algæ and zoophytes.

I found it quite abundant at Stonington, Conn. in July. It is said to occur also at Scotland, Venice, and at the Cape of Good Hope.

2. *Echinella* ——. (Pl. 3, fig. 9.) Corpuscles smooth? lanceolate, truncate; pedicel short, broadly clavate, often nearly circular, supporting the radiating closely aggregated corpuscles.

I detected this very elegant species about a year since in the Hudson River near West Point, where it grows upon Potamogeton, Enteromorpha, &c. It agrees in many respects with E. fulgens, Grev., but that is described as being striate, a character which I have not perceived on our species.

Cocconema.

Carapace simple, bivalve or multivalve, siliceous, fixed by one end, pediculate, longer than broad, pedicel in the direction of the axis of the body. (*Pedicellate Naviculæ.*)

When separated from their footstalks, there is no good character to distinguish them from Navicula, but the unsymmetrical

boat-shaped frustules of Cocconema will *generally* serve to identify them.

1. *Cocconema* ———. (Pl. 3, fig. 10.) Carapace lanceolate, ends obtuse, pedicels repeatedly dichotomous, secondary branches articulated to the primary ones. Striæ were not perceived.

Abundant in the Hudson River at West Point. It appears to be allied to C. lanceolatum of Agardh.

2. *Cocconema* ———. (Pl. 3, fig. 11, *a*, *b*.) These figures represent two positions of a species of Cocconema which is very common in the living state near West Point, and which also abounds as a fossil. In the living state I have but rarely seen it attached to a pedicel. It is generally free, and moves about spontaneously like a Navicula.

I once, on a cold day in October, noticed vast collections of this species which were enveloped in a mucous covering, and which formed large cloud-like masses several inches in extent, investing aquatic plants, stones, &c. Each of these masses was crowded with millions of the siliceous shells of this species.

Ehrenberg mentions C. asperum as a new species detected by him among the fossils from West Point. I am ignorant of its distinguishing features.

Achnanthes.

Carapace simple, bivalve, or multivalve, siliceous, prismatic, longer than broad, fixed by one end, pedicellate, pedicel oblique, ventral, always simple, opening in the middle of the body. Groups, resulting from increase by spontaneous longitudinal division, resembling chains, little banners, plates or ribbons.

Achnanthes brevipes. (Pl. 3, fig. 12.) Corpuscles striate, curved in the middle, ends rounded on the dorsal and ventral sides; pedicel thick, shorter than the body.

I first noticed this species on filaments of Conferva fracta from Providence Cove, R. I., and have since found it abundant on marine Algæ from Stonington, Conn. Small specimens, differing I believe in no essential character, are also very abundant on aquatic plants in the Hudson River at West Point.

The Achnanthes longipes of authors may be a distinct species, but the distinction " pedicel longer than the body," appears to me to be founded on a character liable to much variation. I saw specimens at Stonington having pedicels much longer than the body, yet they appeared to me to agree with E. brevipes in every other respect.

Striatella.

Carapace simple, (siliceous,) fixed by one end, longer than broad, or nearly square, obliquely pediculate in form of little flags, corpuscles without openings in the middle, often forming zigzag chains by spontaneous divisions. (*Stipitate Bacillariæ.*)

1. *Striatella arcuata.* (Pl. 3, fig. 13.) Carapace lamellar, nearly square, with three to seven longitudinal internal lines, transversely striate, polypidoms (flags) in form of ribbons, often curved, nine striæ in $\frac{1}{100}$ line. *Diatoma unipunctatum*, Agardh, Greville, &c.

This species occurs in vast quantities on filiform marine Algæ at Stonington, Conn. It covers the plants in such profusion as to make them glitter in the sunbeams as if covered with crystals. The recent frustules are not flat, but slightly convex, and are usually marked with an internal nearly circular spot, which in my specimens was yellow, not rose-colored as usually described. Considerable variation in the width of the frustules occurs even in the same ribbon. Each plate is transversely striate, the alternate lines not quite reaching to the edge. I saw numerous specimens supported by long pedicels.

Sect. IV. LACERNATA.

Frustulia, *Ehr.*

Envelope double, carapace siliceous, mantle gelatinous, amorphous, corpuscles scattered or in groups.

I have seen no American species of this genus.*

Syncyclia.

Envelope double, exterior mantle gelatinous, carapace siliceous, navicula-shaped, forming by spontaneous division, circular groups surrounded by gelatine. See Pritchard's Infusoria, Plate 4, p. 206.

No American species has yet been detected.

Naunema.

Envelope double, carapace navicula-shaped, siliceous; mantle gelatinous, exterior, tubular; tubes filiform, separate, branching,

* My opportunity to study the marine Bacillaria, has been very slight. I presume therefore, that many marine forms not noticed by me during the two days which I spent at Stonington will yet be detected, and among them will probably be species of Frustulia, Syncyclia and Schizonema.

confervoid, resulting from perfect division of the carapace, and imperfect division of the mantle.

In this genus, corpuscles which cannot be distinguished from those of Navicula are assembled together in vast numbers, in flexible membranous tubes, within which they may often be seen to move freely. They doubtless often leave these tubes, and then appear like species of Navicula.

I have noticed several American species, but I am unable to decide whether they are identical with any hitherto described, as I have had very little opportunity to study our species in a living state and have no foreign specimens or figures to compare them with. I shall therefore content myself with merely giving the forms of the frustules found in each species, and such additional particulars as seem most interesting.

1. *Naunema* ———. (Pl. 3, fig. 14.) The figure represents corpuscles from a branching species found on the shores of Staten Island, N. Y. The tubes are whitish, containing long rows of corpuscles, strung end to end, each of which contains two round globules looking like air-bubbles. No trace of striæ.

2. *Naunema* ———. (Pl. 3, fig. 15.) This figure shows the form of corpuscles which filled short robust unbranched filaments, which were exceedingly lubricous. Bunches of filaments about half an inch in length, were found in great abundance on Zostera, &c. at Stonington, Conn.

3. *Naunema* ———. (Pl. 3, fig. 16.) This figure shows the outline of dried corpuscles from a specimen obtained at Stonington, Conn., where it is very common. Its filaments are branched and form larger and longer bunches than the preceding, with which it occurs.

4. *Naunema* ———. (Pl. 3, fig. 17.) This is from specimens found in immense quantities in the Hudson River, at West Point. The masses have not the green color of the two preceding species, but present a rich brown color. The frustules are in all respects like those of Navicula, and I have often seen them move spontaneously in their tubes, some going one way and others another.

In Pl. 3, fig. 17, *a*, is shown the outline of much longer frustules, found in tubes similar to those just mentioned.

Gloeonema.

Envelope double, carapace siliceous, mantle tubular, tubes simple, often branched, corpuscles curved, resembling Cocconema *in a tube.*

Mr. Berkely has recently published (Ann. and Mag. Nat. Hist. Vol. 7, p. 449) some interesting observations, by which he appears to have proved that the only species of this genus, the singular *G. paradoxum*, consists merely of rows of ova of some aquatic insect. He watched their development into larvæ. I have not seen American specimens.

Schizonema.

Envelope double, carapace siliceous, mantle tubular, tubes united in bundles, split in some places so as to appear branched, corpuscles like those of Navicula.

No American species has yet been detected by me.

End of the Bacillaria.

It was my intention when I commenced the above sketch, to give in connection with it, an account of all the American localities of fossil infusoria, but further reflection has convinced me that this labor is unnecessary. All our fluviatile deposits of fossil infusoria, contain nearly the same species, and all these species are now living. From the great range which the living species have been shown to have in our country, there is great probability that all of the siliceous ones may be detected, if carefully sought for in any of the specimens of fresh-water infusorial deposits. As for the localities at which these fossil infusoria occur, it does not appear that a particular enumeration is necessary. The living animals inhabit in great quantities almost every place where water remains several months in the year, their indestructible shells are therefore to be found in greater or less quantity in the sedimentary deposits of all our bogs, ponds and slow streams. These deposits are most remarkable beneath peat bogs, where they constitute strata many feet in thickness, and of great extent, often composed entirely of the siliceous carapaces of animals so minute that millions of them exist in a cubic inch. The "siliceous marl" which they form, is often so white and light as to be mistaken for magnesia, and Dr. Jackson states that it has actually been sold as such to apothecaries, who were much surprised when informed by him that not a particle of magnesia was present.

Among the vast number of fluviatile localities now known, I think it necessary to allude only to the following, viz. West Point, from which specimens have been examined by Ehrenberg,

whose list of the species is given in this Journal, Vol. XXXIX, p. 193; Blue Hill Pond, and various other localities in Maine, discovered by Dr. Jackson; Manchester, Spencer, Wrentham, Bridgewater, Andover, &c. in Massachusetts, discovered by Prof. Hitchcock, and Smithfield and other places in Rhode Island, discovered by Owen Mason, Esq. The largest and most conspicuous species from all these localities are Navicula viridis, Pl. 2, fig. 16, Navicula ——? Pl. 2, fig. 23, Cocconema ——, Pl. 3, fig. 11, Eunotia arcus, Pl. 2, fig. 26. With these occur various smaller species, and numerous siliceous spiculæ of fresh-water sponge, Pl. 3, fig. 18, *a* to *d*, and other siliceous bodies of organic origin, such as the Amphidiscus rotula of Ehrenberg, Pl. 3, fig. 20, and others whose nature is unknown, but which I suspect to be of vegetable origin, perhaps prickles of aquatic grasses. See Pl. 3, figs. 21, 22 and 23.

The most interesting American deposit of fossil infusoria, is the "infusorial stratum" discovered by Prof. W. B. Rogers, of the University of Virginia. It is peculiarly interesting from its vast extent, the beauty of its species, and from its belonging to the marine tertiary formations. All other American fossil infusoria yet discovered are of fluviatile origin, and of the most recent date.

I have already pointed out the striking correspondence between the fossils of the infusorial stratum of Virginia with those of Oran in Africa. This is shown by the occurrence of vast quantities of various species of Coscinodiscus and Actinocyclus, with Gaillonella sulcata? &c. Believing that it will be of great interest to geologists both at home and abroad to trace out this correspondence of the fossils of regions so far distant, and of beds which are at present referred to different epochs,* I have added to my plate 3d, a number of figures of siliceous bodies not before described, found in the infusorial stratum of Virginia. The following is a brief account of these bodies.

In Pl. 3, fig. 24, *a*, *b*, *c*, are shown different views of small siliceous bodies, which are quite frequent in the infusorial deposits both of Richmond and Rappahannock cliffs. They consist of a concave rhomboidal body, formed of open work, or with large

* Ehrenberg refers the infusorial conglomerates of Oran, &c. to the *chalk* formation, but Rozet considered them as *tertiary* deposits, and Prof. Rogers states that the beds discovered by him separate the *miocene* from the *eocene* tertiary beds of Virginia.

perforations, and having at the extremities projecting spines. I suspect that these belong to the genus Dictyocha of Ehrenberg, several species of which occur at Oran, Caltasinetta, &c.*

Pl. 3, fig. 25, shows a siliceous ring with projecting spines; it is possibly a fragment of the preceding.

Pl. 3, fig. 26, shows a circular ring connected with a concentric hexagon by six rays proceeding from the angles of the hexagon. The spaces within the hexagon and below the rays are perforations. It is possibly another species of Dictyocha. It occurs occasionally among fossil infusoria from Richmond and Rappahannock cliffs.

Pl. 3, fig. 27, shows a curious fragment apparently siliceous, having a campanulate form with a projection at the apex, and pierced with large holes. Fig. 28 shows an ovoid body perforated by similar holes. Of the nature of these curious fossils, I am entirely ignorant. They occur with the preceding.

Pl. 3, fig. 29, shows a triangular binary siliceous body, resembling some of the fluviatile species of Euastrum. The surface is covered with minute dots, some of which form lines leading from the centre to the angles. Perhaps this belongs to Ehrenberg's genus Triceratium, of which species occur fossil at Oran, and living in Cuxhaven.

In Pl. 3, figs. 30 to 35 show siliceous bodies which are quite abundant with the preceding forms, and which I suspect are spiculæ of marine sponges. Many of them show a central perforation, like that in the spiculæ of Spongilla.†

Other interesting forms occur in the infusorial strata of Virginia, but the limits of this paper will not allow me to present any more of them at present. I have transmitted specimens from Richmond to Ehrenberg, and he will doubtless determine to what extent the African and American beds agree in their microscopic fossils. As the infusorial strata of Virginia belong decidedly to the tertiary epoch, and yet appear to agree remarkably with what Ehrenberg considers as chalk marl from Oran, a revision of the evidence upon which the siliceous infusorial conglomerates of Africa and the south of Europe were referred to the cretaceous

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* Since the above was in type, I have seen Ehrenberg's figures of several species of Dictyocha in the Berlin Transactions, and find them to agree with the bodies above referred to.

† I have reason to believe that similar siliceous spiculæ occur in vast quantities in the external rays of some species of Actinia.

group, appears necessary. Should the true age of either the American or African deposits be determined by means of the fossil infusoria, it will be an additional instance of the importance of this branch of microscopic paleontology. It has been well remarked that the microscrope is now as important an instrument for the geologist as the hammer; and indeed the results obtained by microscopic observation of coal, fossil wood, teeth, polythalamia, and infusoria, prove the truth of this remark. The question *cui bono?* to what useful end are your pursuits? can now be triumphantly answered by the lover of microscopic research; but happily, to use the words of the Hon. W. H. Harvey,* the class who now ask this question to naturalists "is neither so numerous or respectable as it was thirty years ago; it is becoming every day less so, and will soon be confined to the ignorant and the sensual." In the language of another distinguished philosopher,† "the time is past when the utility or dignity of such pursuits can be affected by a sneer at the littleness of their objects, as they seem little in the eyes of the indifferent and the ignorant. Every thing is great or small only by comparison; the telescope teaches us that the world is but an atom, and none know better than microscopical observers that every atom is a world."

Note.—Portions of the above paper were read before the Association of American Geologists at their meeting in Philadelphia in April, 1841.

Explanation of Plate 3.—The figures of this plate were drawn by means of the camera lucida, and to the same scale as was used in Plates I and II.

Fig. 1. Synedra ——. One group of frustules, with part of another, parasitic on aquatic plants in the Hudson River. *a*, fleshy base; *b*, fleshy projection at the summit. Brackish water.

Fig. 2. Synedra ——, *a*, *b*, different positions. Fresh water, also fossil.

Fig. 3. Podosphenia? possibly a Gomphonema. Fresh water.

Fig. 4. Gomphonema minutissimum, *a*, largest size; *b*, smaller individuals. Hudson River near West Point.

Fig. 5. Gomphonema ——, *a*, *b*, different positions; 5 *c*, sketch of a group of individuals with the branching pedicels.

Fig. 6. Gomphonema acuminatum, *a*, *b*, different positions. Fresh water, also fossil.

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* Manual of British Algæ, by the Hon. William Henry Harvey.

† Richard Owen, Esq. Address before the Microscopic Society of London, 1841.

Fig. 7. Gomphonema ——, 7 *a*, another view of a frustule. Marine, Stonington, Conn.

Fig. 8. Echinella flabellata, a single group. Fig. 8, *b*, a sketch of several groups slightly magnified, drawn from the living specimen. Marine, Stonington, Conn.

Fig. 9. Echinella ——, a group parasitic on an aquatic plant. Fig. 9, *a*, *b*, different positions of a single frustule. Hudson River.

Fig. 10. Cocconema ——, group supported on the branching pedicel. Hudson River.

Fig. 11. Cocconema ——, *a*, *b*, two positions of an individual separated from its pedicel.

Fig. 12. Achnanthes brevipes, several groups parasitic on a Conferva; *b*, a larger pair; *c*, back view. Stonington, Conn., Hudson River, &c.

Fig. 13. Striatella arcuata. Marine, Stonington, Conn.

Fig. 14. Naunema ——, *a*, *b*, two positions of the frustule separated from its tube. Marine, Staten Island, N. Y.

Fig. 15. Naunema ——, *a*, frustule separate from its tube. Stonington, Conn.

Fig. 16. Naunema ——, *a*, *b*, two positions of a single frustule. Stonington, Conn.

Fig. 17. Naunema ——, group of frustules within their tube. West Point, N. Y.

Fig. 17, *a*. Naunema ——, single frustule. West Point.

Fig. 18, *a* to *d*. Spiculæ of Spongilla or fresh-water sponge.

Fig. 19, *a*, *b*. Probably spiculæ of another species of Spongilla. *b*, group of three individuals.

Fig. 20. Amphidiscus rotula of Ehrenberg, probably derived from a Spongilla. Fossil at West Point, near Boston, Wrentham, &c., also in South America.

Fig. 21 to 23. Siliceous bodies of organic origin, found with fossil fresh-water infusoria.

Fig. 24. Dictyocha fibula? Ehr., common among fossil marine infusoria in the infusorial stratum of Virginia at Richmond and Rappahannock cliffs.

Fig. 25. Fragment of the preceding.

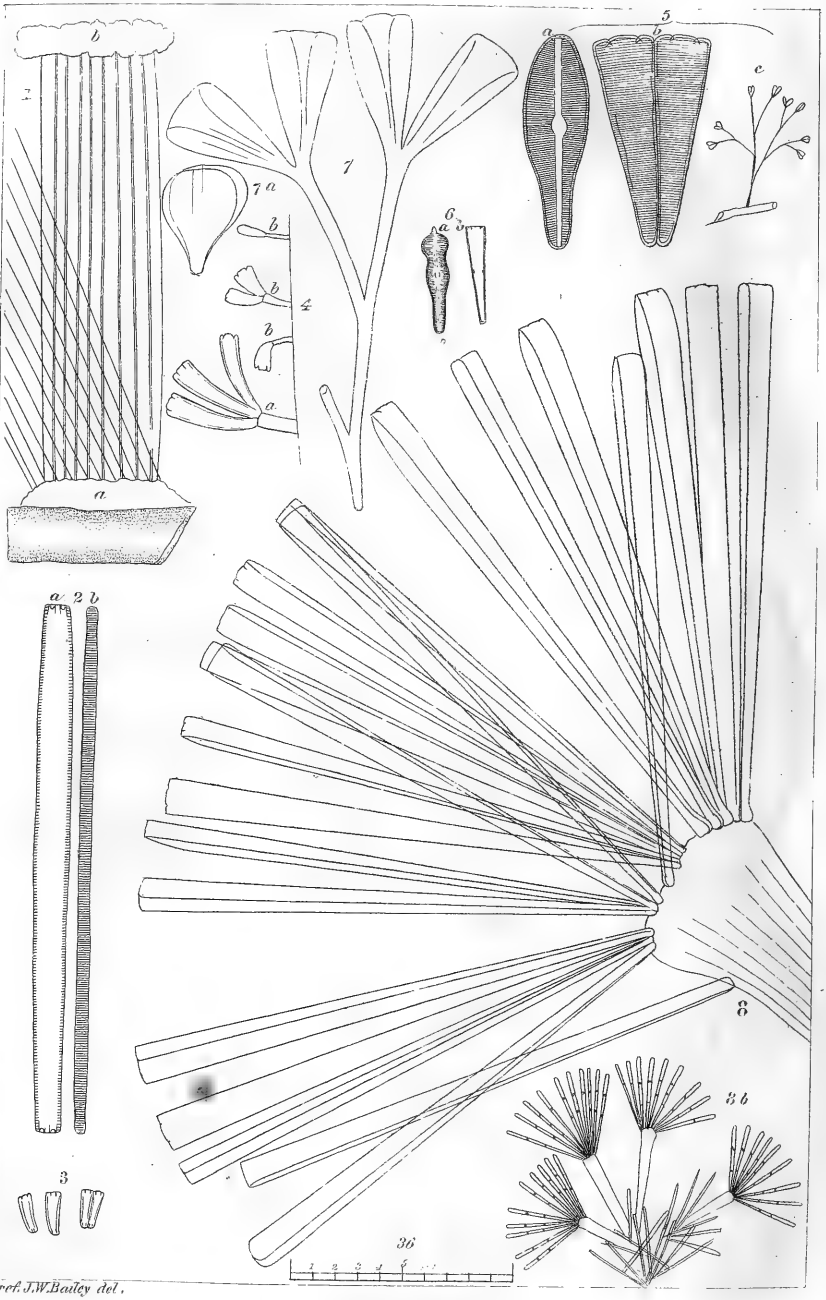
Fig. 26. Dictyocha speculum, Ehr., with the preceding.

Fig. 27 and 28. Siliceous bodies, found with the preceding.

Fig. 29. Binary, triangular, siliceous bodies, found with the preceding.

Fig. 30 to 35. Siliceous spiculæ, &c. probably derived from marine sponges or Actinia, found with the preceding.

Fig. 36. Scale showing $\frac{10}{100}$ths of a millimetre, magnified equally with the drawings.



Prof. J. W. Bailey del.

Plate Third, Part Third.

ILLUSTRATIONS TO PROF. J. W. BAILEY'S

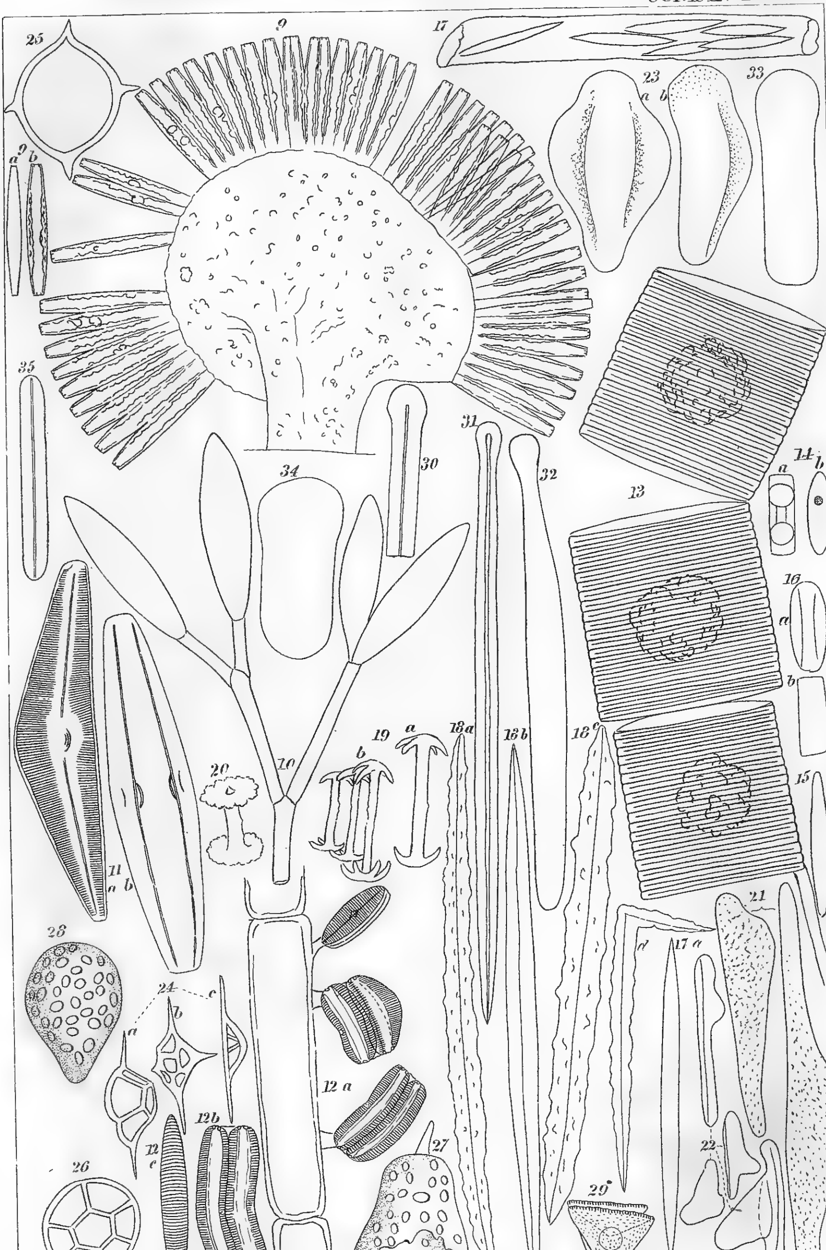


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Plate Third, Part Third

PAPER ON AMERICAN BACILLARIA.

Art. VI.—*A Monography of the North American Cuscutineæ;* by George Engelmann, M. D., of St. Louis, Missouri.

In directing my attention to the different forms of Cuscuta of this vicinity, I was surprised to find several distinct species, as well as a remarkable allied genus, while only a single species, the *Cuscuta Americana*, is noticed in botanical works. Having been induced to examine particularly as well the species of this neighborhood, as the specimens with which my correspondents in different parts of the country have favored me, I offer the result of my investigations to the public, with the view of directing the attention of botanists throughout our wide-spread country to the subject; trusting that this neglected tribe of plants may thereby be further elucidated. I therefore avail myself of this opportunity to request botanists in different parts of the country to communicate specimens of the Cuscutæ of their vicinity, accompanied by the plant on which they grow.

Order Convolvulaceæ, *R. Br.*

Tribe. 2. Cuscutineæ, *Link.*

Leaves reduced to scales. Embryo spirally rolled around a mucilaginous albumen, without cotyledons.

This remarkable tribe is appended to *Convolvulaceæ*, and bears to that family the same relation which *Monotropeæ* bear to *Pyrolaceæ*, and *Orobancheæ* to *Antirrhineæ:* these plants, which may be likened to Phanerogamous Fungi, being all destitute of verdure and of proper leaves, (bearing scales in place of the latter, but never leafless in the full meaning of the term;) while in the structure of their flowers they agree with plants of the highest organization. They are all parasitic on other vegetables; the Cuscutineæ on their stems; most Orobancheæ on their roots; and the Monotropeæ on their mouldering remains: hence they are obviously analogous to the class *Entozoa* of the animal kingdom; and may be termed *Epiphyta*, growing on plants.

The Cuscutineæ are distinguished from other Epiphyta by their growing on and turning around the stems (and occasionally the leaves) of other plants, as well as by their large seeds, resembling those of Convolvulus, and presenting a long and slender embryo, which is spirally coiled around a mass of mucilaginous

albumen. *Monotropeæ* and *Orobancheæ* have extremely minute seeds, in some respects similar to the spores of Acotyledonous plants. The seeds of Cuscutineæ germinate in the ground; but soon finding the plants round which they twine, (turning constantly to the left like all Convolvulaceæ,) they strike their papillose roots into the epidermis of the stem, from which they subsequently derive their nourishment; their own original stems soon withering away, so that the plant is no longer in direct communication with the earth.

As in the *Entozoa*, the same species is only the same or some nearly related animal, so in the *Epiphyta*, each species is for the most part restricted to the same or similar plants. This is more constantly the case in *Orobancheæ*, where the germinating embryo fixes itself at once upon its favorite plant; but in Cuscuta, where the seed germinates in the ground, and the stem afterwards lays hold of the plant which affords its nourishment, it frequently twines around all the plants in the neighborhood, and is capable of extracting from them its food. Some species, however, are more constant in their predilections than others; as, for example, the European *Cuscuta Epilinum*, which never grows on any other plant than flax; and our *Lepidanche Compositarum*, which is confined to *Solidago*, *Helianthus*, and some other *Compositæ*. Yet several, like the European *Cuscuta Epithymum* and the American *C. Polygonorum*, live promiscuously on most plants within their reach, evidently preferring, however, some particular species or genus, and seldom found except in its immediate vicinity. I have therefore ventured, as far as practicable, to name the species of Cuscuta after the plant upon which they grow; in accordance with the nomenclature frequently adopted of late in the case of parasites, especially in the genus *Orobanche*, (Examp. *Orobanche Galii*, *O. Eryngii*, *O. Scabiosæ*, *O. Salviæ*, etc.): thereby designating an important circumstance in the history of the plant.

Before I proceed to describe the North American species known to me, it may be well to present a general

Conspectus of the species that have come under my observation.

I. Cuscuta, *Linn.* Sepals united into a 4–5-cleft calyx.

§ 1. *Styles united into one.*

1. C. monogyna, *Vahl.* Eastern Europe.

§ 2. *Styles two.*

* *Stigmas capitate.—European.*

† *Flowers generally pentamerous.*

2. C. Epithymum, *Linn.* Segments of the calyx and corolla acuminate.—Europe.

3. C. Epilinum, *Weihe.* Flower globose: segments of the calyx and corolla orbicular, abruptly acuminate.—Europe.

4. C. planiflora, *Tenore.* Flower campanulate, open.—Italy.

†† *Flowers generally tetramerous.*

5. C. Europæa, *Linn.* Lobes of the calyx and corolla obtuse.—Europe.

** *Stigmas capitate.—American.*

A. Corolla cylindric, its remains covering the ripening capsule.

† *Flowers generally pentamerous.*

6. C. Chilensis, *Ker.* Corolla much longer than the campanulate calyx: anthers sessile.—Chili.

7. C. Cephalanthi. Lobes of the calyx and corolla obtuse: anthers with filaments.—St. Louis.

†† *Flowers generally tetramerous.*

8. C. Coryli. Lobes of the calyx and corolla acute.—St. Louis.

B. Corolla campanulate, its remains persistent at the base of the ripening capsule.

† *Flowers generally pentamerous.*

9. C. vulgivaga. Carinate lobes of the calyx and the lobes of the corolla obtuse.—Vermont to Georgia and Missouri.

10. C. Saururi. Smooth, lobes of the calyx and corolla obtuse.—Western New York to Missouri.

11. C. pentagona. Lobes of the 5-angled calyx smooth, roundish; those of the corolla acuminate.—Virginia.

12. C. verrucosa. Lobes of the campanulate calyx verrucose, roundish; those of the corolla acuminate.—Texas.

†† *Flowers generally tetramerous.*

13. C. Polygonorum. Lobes of the calyx and corolla acute.—St. Louis.

II. Lepidanche. Calyx consisting of 10–15 imbricated sepals.

1. L. Compositarum. Western United States.

(1.) CUSCUTA, *Linn.* (Dodder.)

Calyx monosepalous, 4–5-cleft, persistent. Corolla campanulate or urceolate, 4–5-cleft, styles one or two. Capsule 2-celled, 4-seeded.

Twining parasitic plants, bearing the general character of the family. The stem is filiform, simple or generally branched, of a whitish, yellowish or orange color, with scaly leaves. The inflorescence is a cyme, (with a central flower opening first, and axillary or lateral flowers, which open afterwards,) with whitish sessile or pedunculate flowers, more or less clustered (conglomerate) in some, and rather loose (commonly called paniculate) in other species. Some bracts are observable on the peduncles and pedicels, but they are always easily distinguished from the calyx.

The first or central flowers of the inflorescence are mostly 5-parted, but the lateral or secondary ones are in some species

regularly 4-parted, in others nearly always 5-parted. The calyx is constantly monosepalous, deeply and somewhat irregularly 4 to 5-parted, and persistent.

The corolla is cylindric, urceolate, or campanulate, with the limb erect, campanulate, spreading or reflexed, and together with the stamina either persistent at the base of the capsule, or more frequently separated from its insertion and covering its summit. Its texture is in some species nearly membranaceous, in others thicker and more fleshy.

The stamina are united with the tube of the corolla up to the base of the segments. Near their base, within the tube of the corolla, they bear a scale which is evidently not a distinct organ, but only an appendage of the stamina. They are present in all the species which I have examined; sometimes consisting only of one or few teeth on both sides of the filament, (as in C. Coryli,) but commonly forming a distinct lamina. In some they are bifid, in others undivided; but in all either crenulate or fimbriate, or laciniately or pinnatifidly divided. They are erect and appressed to the tube in several species; while in others they are convergent, closing the tube and including the ovary.

The ovary is always 2-celled, 4-ovulate; the styles two, (in a single species united into one,) frequently unequal in length; in a few cases supported by a stylopodium. The stigma is either filiform, as in the European, or capitate, as in the American species.

The capsule is globose or depressed, crowned by the persistent styles and stylopodium (when the latter is present); it is 2-celled, and sometimes 4-seeded; but more generally by abortion, 3-, 2-, and even 1-seeded. In the European species, it separates by circumcision from its base, leaving the dissepiment persistent on the calyx. In the American, the capsule does not appear to open regularly, but it separates easily from the calyx when ripe.

I have seen very few abnormal irregularities in the flowers of Cuscuta. Sometimes one or more segments of the corolla are partially or entirely changed into a stamen, and the capsule is occasionally 3–4-carpellary, instead of 2-carpellary.

1. Cuscuta Cephalanthi, *n. sp.*

Stem high, branching; flowers somewhat pedunculate, mostly 5-parted; tube of the corolla cylindric, (after flowering ventricose,) twice the length of the obtuse speading segments, and of

the ovate obtuse lobes of the calyx; stamens shorter than the limb; the scales ovate, laciniate, nearly appressed; styles equal to the depressed ovary; capsule depressed, covered by the remains of the corolla.

On Cephalanthus; also on Vernonia, Aster, Bœhmeria, and other plants, (especially Compositæ,) on the margin of ponds and swamps near St. Louis, where it is the most common species. I have observed it since 1833; but have only met with it in the immediate vicinity of Cephalanthus. July to September.

The whole plant is whitish or pale yellow; the stem high and much branched; the flowers sometimes clustered and nearly sessile, but generally more or less pedunculate, and disposed in compact or rather loose cymes. The divisions of the calyx are very unequal, ovate, or roundish, obtuse, rarely with a little point, covering only the lower half of the tube. The tube itself is perfectly cylindrical in the young flower; but afterwards swells by the enlargement of the ovary, and becomes somewhat urceolate. The lobes of the corolla are ovate, obtuse, somewhat auricled at the base, and campanulate or spreading, half as long as the tube, but longer than the stamina. The corolla is membranaceous, not fleshy. The flowers are mostly 5-parted; but the latest ones of the season are often 4-parted, or even 3-parted. The ripe capsule separates easily from the calyx, apparently without bursting.

2. Cuscuta Coryli, *n. sp.*

Stem branching; flowers peduncled, subumbellate, mostly 4-parted; tube of the corolla cylindric, equal in length to the ovate acutish crenulate inflexed lobes, and the acute carinate segments of the calyx; stamens a little shorter than the limb; the scales appressed, bifid, consisting of few teeth; styles as long as the ovary with the stylopodium; capsule depressed, covered with the remains of the corolla, crowned by the stylopodium and the reflexed styles.

Var. *β*. stylosa: styles much longer than the ovary, exserted.

On Corylus, in the barrens west of St. Louis, in August and September. *β*. On Solidago, in dry prairies near St. Louis.

This species is nearly related to the foregoing, but may be easily distinguished by the shape and proportions of the calyx and corolla, and by the stylopodium on the ovary. The corolla is

fleshy, not membranaceous, and finely crenulate; the lobes always erect and somewhat incurved. The scales of the filaments are smaller than in any other of our Cuscutæ, and consist of one or two teeth on each side of the filament, (where it adheres to the tube,) thereby indicating the true nature of these singular "nectaria." It appears to be rarer than the other species, and grows more on dry ground.

3. Cuscuta vulgivaga, *n. sp.*

Stem branched; flowers pedunculate, somewhat glomerate or more lax, generally 5-parted; tube of the corolla deeply campanulate, longer than the pellucid-punctate open (finally reflexed) lobes, and the roundish, carinate, obtuse and slightly crenulate segments of the calyx; scales convergent, fimbriate, united at the base; styles about as long as the ovary (with the stylopodium?); the remains of the corolla persistent at the base of the globose capsule.

Var. α. laxiflora: flowers in loose cymes.
β. glomerata: flowers conglomerate.
γ. tetramera: flowers in umbelliform cymes, 3–4-parted.

This species has apparently not only the widest range of all the American Cuscutæ, but is less restricted to the same genus or family of plants. Indeed I have scarcely met with it twice upon the same species. Var. α. is the southern and western form: Western New York on Decodon, *Dr. A. Gray;* Missouri on Cephalanthus and Amphicarpæa, and Georgia, on ——? *J. Carey;* Alabama, on Salix and Aster, *S. B. Buckley.* Var. β. is the northern form: my specimens are from Vermont, on Leersia, and New Hampshire, on Solidago, both from *Mr. J. Carey.* Var. γ. Connecticut, on Urtica, *J. Carey.*

The *Cuscuta vulgivaga,* is perhaps in part the Cuscuta Americana of Linnæus, and of many later botanists. But their diagnoses are too incomplete to decide the point, and different species undoubtedly have been confounded under this name. Even Linnæus himself (Spec. Plant. ed. 1, p. 124) referring to Gronov. Virg. and to Sloane, Hist. I, p. 201, t. 128, f. 4, confounds two distinct species. Which of them is to be the *C. Americana?* Linnæus has only the following words: "Cuscuta floribus pedunculatis." Michaux, (I, 175): "Cuscuta, floribus pedicellatis, pentandris." Pursh, (I, 116): "C. fl. pedunculatis umbellatis

5-fidis." Other botanists add, "stigmatibus capitatis." Nuttall, gen. (II, addit.) on the other hand has it: "flowers mostly pentandrous and sessile;" and Sprengel (Syst. Veg. I, 864) brings his C. Americana under the section with glomerate subsessile flowers. While these authors refer to one or more North American species, others apply the name with at least equal justice to a West Indian plant. Linnæus himself cites Sloane, Hist. I, t. 128, f. 4. After him Jaquin, (Stirp. Am. p. 24,) Swartz (Obs. p. 54) and others describe a West Indian species. The name may therefore properly be reserved for Sloane's plant, or may be discarded altogether. The only reason I have in supposing that most North American authors give it to *Cuscuta vulgivaga,* is that this is the most common and the widest spread species in the United States, and has generally the flowers longer peduncled than any other.

This Cuscuta is intermediate between C. Cephalanthi and C. Saururi. In all three the lobes of the calyx and corolla are obtuse, and the former shorter than the tube of the corolla. But our plant is distinguished from both by the carina of the lobes of the calyx, which is formed by larger uneven prominent cells, and by the large pellucid dots in the substance of the corolla, which may be mistaken for glands, but are nothing but cells larger than the rest of the tissue. The carinæ of the calyx are most prominent on the three outer lobes, and sometimes hardly perceptible on the two inner; but even then the large irregular cells are easily distinguished by the lens. The lobes of the corolla are shorter than the tube, as in C. Cephalanthi: the scales are large and incurved, and the corolla remains at the base of the capsule, as in C. Saururi. The tube is campanulate, but deeper cleft than in C. Saururi or C. Polygonorum. The flowers and fruit are larger than in C. Cephalanthi, and (especially in var. α.) nearly of the same size as in C. Saururi. The styles are in some specimens a little longer, in others a little shorter than the ovary, which appears to be crowned by a stylopodium: this however it is hardly possible to ascertain satisfactorily in the dried specimens.

4. Cuscuta Saururi, *n. sp.*

Stem low, branching; flowers 5-parted, somewhat pedunculate, at length in spikes; tube of the corolla campanulate, equal to the obtusish campanulate or spreading lobes, and longer than

the obtuse segments of the calyx ; stamens as long as the limb ; the scales pinnatifid-laciniate, convergent, covering the ovary ; styles as long as the ovate-globose ovary with the stylopodium ; remains of the corolla persistent at the base of the subglobose capsule.

Margin of lakes and swamps, in the "American Bottom" opposite St. Louis, on Saururus, where it was discovered in September, 1841, by my friend, Ch. Geyer, the indefatigable botanist who has signalized himself in the North Western Expedition of Mr. J. N. Nicollet in 1839. Alabama, *Dr. A. Prout.* Texas, on Bœhmeria, Polygonum, &c., *F. Lindheimer.* A variety with rather larger calyx-lobes, in other respects perfectly agreeing with the above description, was obtained by Dr. A. Gray, in Western New York, (also on Saururus ?)

This species bears a great resemblance to C. Polygonorum ; but differs from it in the much stouter stems, the greater size of the flowers, the larger convergent scales, and the stylopodium on the ovary. The stems are one third of a line or more in diameter, and are stouter than in any other of our species. It is the latest species in blossom, the flowers not appearing before the beginning or middle of September ; while C. Polygonorum commences in August, and C. Cephalanthi and C. Coryli, which are the earliest flowering species of our neighborhood, are in bloom by the end of July.

5. Cuscuta pentagona, *n. sp.*

Stem branched ; flowers pedunculate, subumbellate, small, 5-parted ; tube of the corolla open campanulate, shorter than the long acuminate lobes, and the smooth, roundish, obtuse lobes of the 5-angled calyx ; stamens shorter than the limb ; the scales ovate, fimbriate, convergent ; styles filiform, about equal to the globose ovary ; capsule ——.

On Euphorbia or Tragia, Norfolk, Virginia, *Mr. Rugel ;* communicated by Dr. Gray. Also near Houston, Texas, on different low herbs in a wet prairie ; flowering in April, *F. Lindheimer.* Beardstown, Illinois, in sandy soil, *Ch. Geyer.*

This species bears some resemblance to the C. Polygonorum, to which it is related by the campanulate flower and the acute lobes of the corolla ; but is easily distinguished by the small size of the flowers, the 5-angled calyx, whose lobes are not triangular,

but roundish and obtuse. The angles are formed by the margins of the lobes of the calyx and correspond with the petals, while in C. Coryli the five angles, formed by the five prominent midribs, alternate with the lobes of the corolla.

6. Cuscuta verrucosa, *n. sp.*

Stem low, branching; cymes loose, few-flowered; flowers (small), long-peduncled, 5-parted; tube of the corolla campanulate, shorter than the lanceolate acuminate lobes, and nearly equal to the ovate subacute segments of the verrucose or somewhat hispid calyx; scales ovate, fimbriate, equalling the tube; styles as long as the ovary; capsule globose, surrounded at the base by the persistent corolla.

Var. *α.* hispidula: inflorescence, and frequently also the branches, hispid or glandular-pilose; lobes of the calyx acute, shorter than the tube of the corolla.

β. glabrior: cymes more or less glabrous, lobes of the calyx broader, somewhat obtuse, nearly as long as the tube of the corolla.

Texas: var. *α.* in dry sterile prairies, west of Houston, on Euthamia, Schrankia, Aster, Ambrosia, Evolvulus, and other low herbs; flowering in April and May, *F. Lindheimer.* *β.* with the preceding variety, *F. Lindheimer:* on Petalostemon, *Drummond,* (3d collection, No. 247.)

This species is the lowest of all the American Cuscutæ, and has, together with the foregoing, the smallest flowers; it grows on open prairies, in dry soil: in all these respects therefore it takes in Texas the place of *Cuscuta Epithymum* in Europe. Like that species it is not restricted to a few plants, but appears to creep over every thing in its way. It is the only Cuscuta known to me with any appearance of pubescence.

Stem from four to six inches high, smooth (*β.*) or more or less hispidly pubescent with pellucid vesicular hairs, (*α.*) especially in the inflorescence. Peduncles filiform, many times longer than the flowers. Calyx always rough, but the vesicles less hair-like, more glandular, or when dry like warts. In flowering, the calyx is campanulate, or even somewhat turbinate, but soon after assumes a hemispherical shape, which is the one figured in the plate. Lobes of the corolla very acute, spreading, white; after flowering the tips incurved, turning brown. Stigmas globose, purplish-brown.

This Texian species is nearly related to C. pentagona: the size of the flowers, shape of corolla and the scales, are the same; but it is easily distinguished by the loose and few-flowered cyme, and by the tuberculate or hispid-campanulate (not pentagonous, smooth, and membranaceous) calyx.

7. Cuscuta Polygonorum, *n. sp.*

Stem low, branching; flowers subsessile, glomerate, mostly 4-parted; tube of the corolla campanulate, nearly equal to the acute campanulate or spreading lobes, and the acute segments of the calyx; stamens as long as the limb; the scales mostly bifid, laciniate, appressed; styles as long as the depressed ovary; remains of the corolla persistent at the base of the depressed capsule.

On different species of Polygonum, also on Lycopus, Penthorum, and other plants in the neighborhood. August and September.

This is a much lower plant than C. Saururi, etc., with orange-colored stems, twining round the Polygona in overflowed places, the bottoms of sink-holes, or margins of ponds, west of St. Louis, where in the year 1839 my friend *F. Lindheimer*, now in Texas, to whose zeal and kindness I owe many specimens from that interesting country, first discovered it. In the following year, I found it on the banks of Illinois river, near Peru, in thickets formed by immense Ambrosiæ, with Bidens, Spartina, etc. Whether any Polygonum was there I cannot recollect, having at the time paid no particular attention to this point. The flowers of the specimens from Peru are a little more peduncled, and the very acute segments of the calyx rather longer than the tube of the corolla; but I observe no other difference.

This and C. Saururi, are easily distinguished from the others by their orange-colored stems, their larger open campanulate flowers, with the remains of the corolla always at the base of the capsule. The scales of the filaments in C. Polygonorum are intermediate between C. Coryli and C. Cephalanthi in shape; but are more laciniate than in the former. They are appressed to the corolla; so that the large depressed ovary appears naked in the open tube; while in C. Saururi it is covered by the convergent or inflexed multifid scales.

Note.—Since the manuscript of this article has been communicated to the American Journal, my attention has been directed to one or two species of Cus-

cuta indicated by the late Mr. Beyrich, and mentioned by Sir Wm. Hooker in his excellent *Flora Boreali-Americana*, (Vol. 2, p. 77,) and in the first volume of the *Companion to the Botanical Magazine.*

C. umbrosa of Beyrich, in herb. Hook. (*Fl. Bor.-Am. l. c.*) from Canada, the North West Coast, as well as the United States, I am unable to determine from the characters given. It may be either my C. Saururi, or C. vulgivaga, β. glomerata: the length of the styles does not appear to afford constant characters in this genus.

C. arvensis of Beyrich, in herb. Hook. (C. Americana? *Hook. fl. Bor.-Am. l. c.*) is perhaps my C. vulgivaga, α. laxiflora. According to Hooker, Douglas collected it in Oregon.

C. coronata, of Beyrich, in herb. Hook. is enumerated but not characterized in *Hook. Compan. to Bot. Mag. 1, p.* 173. New Orleans, Drummond, 1833, on the stems of Laurus Carolinensis.

C. Epilinum, Weihe, has been introduced, with flax, into some parts of this country, especially Chester County, Pennsylvania, *fide, Darlington, Flora Cestrica, Ed. 2.*

(2.) LEPIDANCHE,* *n. gen.*

Calyx consisting of many imbricated scales, persistent. Corolla tubular, 5-cleft. Styles two. Capsule 2-celled, 2-seeded.

Very similar to Cuscuta when young; but different in appearance when in flower or fruit. The stem which connects the different clusters of flowers having then disappeared, the latter only remain, consisting of innumerable crowded sessile flowers, and scarious scales, spirally and most tightly coiled (with one or several turns) around the stems of the supporting plant, which at a distance appears as if a rope were twisted round it. The flowers are so crowded that many are abortive, and as it were strangled, presenting nothing but a bunch of scales; and others, which are apparently perfect, do not mature seed.

The principal difference between this genus and Cuscuta consists in the calyx, which is not monosepalous, but is composed of numerous imbricated scales; of which the two or five exterior, being much smaller, may be considered as bracts; while the ten inner, which are nearly equal in size and shape, crenulate, and with reflexed or squarrose summits, appear to constitute the proper calyx. The corolla and stamens, with their scales, are entirely similar to the corresponding organs in Cuscuta: so is the ovary; but the unequal styles are generally longer in proportion, and the stylopodium is as large as the ovary proper, or even lar-

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* From λεπις *a scale*, and αγχειν *to strangle*: a scaly plant, strangling those on which it grows.

ger. The ovary is 2-celled and 4-ovulate: but I have never seen more than two seeds, separated by the incomplete dissepiment; and frequently only a single seed ripens.

LEPIDANCHE COMPOSITARUM.

Stem low, branching; flowers closely sessile, conglomerate, 5-parted; tube of the corolla nearly cylindrical, longer than the imbricated calyx, which consists of ten to fifteen scales, twice as long as the oblong obtuse spreading or reflexed lobes of the corolla; stamens equal to the limb, exserted; scales pinnatifidly laciniate, convergent, covering the ovary; styles twice as long as the ovary with the stylopodium; capsule globose, enveloped by the scales of the calyx, crowned by the stylopodium and styles, and covered by the remains of the corolla.

Var. α. SOLIDAGINIS: flowers smaller; lobes of the limb reflexed; stylopodium half as large as the ovary.

β. HELIANTHI: flowers larger, lobes of the limb spreading; scales of the filaments united with one another forming a 5-lobed crown in the tube; stylopodium larger than the ovary.

This singular plant appears to be peculiar to the western prairies. I have observed it since 1833 in wet prairies around St. Louis,* on Solidago, (also on Vernonia, *Ch. Geyer*,) and *Dr. Clapp* has found it on Silphium at New Albany, Indiana; the second variety I have gathered on Helianthus since 1838 in similar localities; flowering in August and September. These varieties may prove distinct species; but for the present I am unable to distinguish them by more important characters than those given above.

The flowers are always 5-parted; the tube is not exactly cylindrical, but a little wider at the mouth than at the base, rather obconic. The styles are longer than in any of our Cuscutæ, and almost always unequal; they are inserted on a distinct stylopodium, which is larger than in any Cuscuta. The stigma is capitate, as in all American Cuscutæ.

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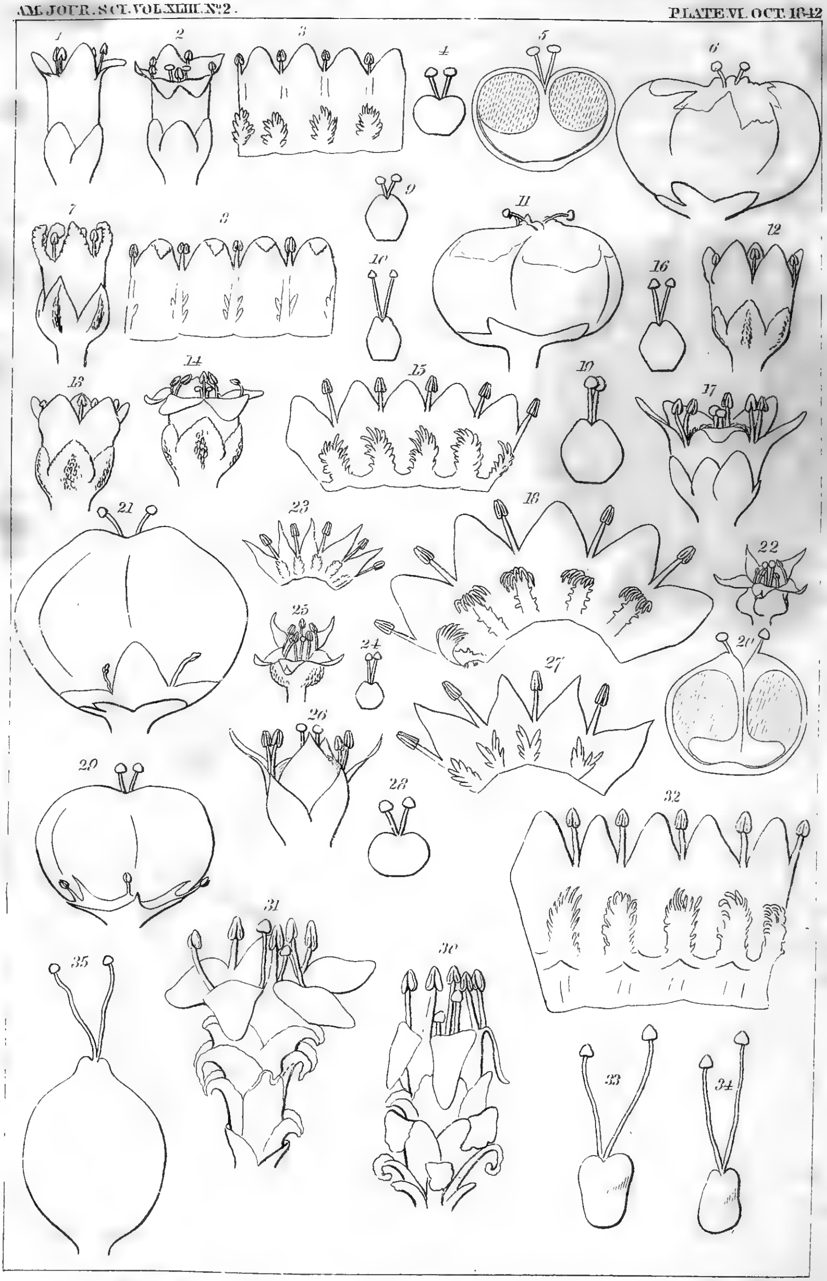
* This is manifestly the *Cuscuta Americana* (from St. Louis) of Hooker's account of Drummond's collections, in the *Companion to the Botanical Magazine, I, p.* 173; of which it is remarked, that "Some of the specimens seem to have all the flowers abortive, and turned into scales, which are excessively crowded, and form a dense wreath of a pale straw-color, around the branch of some shrub."



NORTH AMERICAN CUSCUTINEÆ. by Dr. ENGELMANN.

See page 315

EXPLANATION OF PLATE VI.

Fig. 1–6. *Cuscuta Cephalanthi.*—1. A tetramerous; 2, a pentamerous flower. 3. Corolla laid open. 4. The ovary. 5. Vertical section of a half-grown capsule. 6. Capsule invested by the remains of the corolla.

Fig. 7–11. *C. Coryli.*—7. A flower. 8. Corolla laid open. 9. Ovary and styles. 10. Same of var. *β.* 11. Capsule invested by the remains of the corolla.

Fig. 12–16. *C. vulgivaga.*—12–14. Flowers. 15. Corolla laid open. 16. Ovary.

Fig. 17–21. *C. Saururi.*—17. The flower. 18. Corolla laid open, with the inflexed scales. 19. Ovary. 20. Vertical section of the half-grown capsule. 21. Mature capsule.

Fig. 22–24. *C. pentagona.*—22. Flower. 23. Corolla laid open. 24. Ovary.

Fig. 25. *C. verrucosa.*—Flower.

Fig. 26–29. *C. Polygonorum.*—26. Flower. 27. Corolla laid open. 28. Ovary. 29. Capsule.

Fig. 30–35. *Lepidanche Compositarum.*—30. Flower of var. *α.* 31. Flower of var. *β.* 32. Corolla of *β.* laid open. 33. Ovary and styles of var. *α.* 34. Same of *β.* 35. Capsule.

N. B. The flower represented in fig. 1, is a line in length; all the others are enlarged in the same proportion.

Art. VII.—*A Catalogue of the Mammalia of Connecticut, arranged according to their natural families;* furnished for the Yale Natural History Society, by Rev. James H. Linsley, Member of the Conn. Acad. of Arts and Sciences, of the Yale Nat. Hist. Soc., of the Boston Soc. of Nat. Hist., &c.

Read before the Yale Natural History Society, April, 1842.

To the Secretary of the Yale Natural History Society—

My dear Sir—At the request of several members of the Connecticut Academy, to furnish a catalogue of the class Mammalia of this State, I take the liberty to present it to the Yale Natural History Society, as falling more appropriately under their attention and direction.

In order to avoid compiling a catalogue derived simply from books, as has been too often done without any advantageous results, I have delayed presenting mine, in order to make myself

personally acquainted with nearly every species hereinafter named. Although it has been attended with much labor and some expense, I have been abundantly compensated in the pleasure the examination of the subject has afforded me. As nothing of the kind (it is believed) has heretofore been attempted in this State, it is difficult to determine how many species, hitherto unknown in the State, I have been able to add to our list. But several of my smaller quadrupeds have heretofore been supposed by naturalists not to exist in this region; and one species is entirely *new* in this country, except that another specimen was discovered about the same time at Rochester, New York.

Order CARNIVORA.

Family Vespertilionidæ. The Bat Family.

1. Vespertilio Carolinensis, of Geoffrey, Carolina Bat, Stratford.
2. V. noctivagans, Cooper, (Auduboni, Harlan,) Stratford.
3. V. Noveboracensis, Linn., the New York Bat, Stratford.
*4. V. pruinosus, Say, Hoary Bat, Stratford.
*5. V. subulatus? Say, Awl-eared Bat, Northford.

Family Soricidæ. The Shrew Family.

*6. Sorex brevicaudis, of Say, Short-tailed Shrew, Stratford.
*7. S. Dekayi, of Bachman, Dekay's Shrew, Stratford.
*8. S. parvus, Say, Small Shrew, Stamford.
*9. S. platyrrhinchus, Dekay, least and beautiful Shrew, Stratford.

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*4. I took a specimen of the Hoary Bat, December, 1841, that measured 17 inches across the wings, and 6 inches in length, and under circumstances which induced the belief that this bat migrates southerly in winter.

*5. I have seen a species of bat at Northford, more common there than either of the others, but have had no recent specimen, yet believe it to be the *subulatus* of Say. I have specimens in my cabinet of the other four species.

*6 and 8. An account of these two species, as discovered by me in Connecticut, was published in this Journal, Vol. xxxix, p. 388.

*7. Of the Dekayi, I have taken several specimens, both old and young.

*9. This beautiful little quadruped was taken in a decayed apple-tree log in Stratford, Jan. 22, 1840. Total length 4 inches; body and head 2.5 inches; length of tail 1.5 inches; length of head .8 inch; end of nose to end of ear .9; end of nose to fore leg 1 inch; length of nose to upper incisors .2 inch; height of ear .1 inch; length of nose to rictus .3; tip of nose deeply lobed, and nearly a line deep; total weight of animal 47 grains. Color, upper parts dark reddish brown;

Family TALPIDÆ. The Mole Family.

*10. Scalops Canadensis, Cuv., Shrew Mole, common, Stratford.

*11. Condylura longicaudata, Desmarest, long tailed Star-nose Mole, Stratford.

*12. C. macrura, Harlan, Black Star-nose Mole, Stratford.

Family URSIDÆ. The Bear Family.

*13. Ursus Americanus, Pallas, common, Black Bear. ?

*14. Procyon Lotor, Cuv., Raccoon, common, O. L.

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nose and tail, upper side dull red, under parts dark gray or light mouse-colored; end of tail a pencil of black hairs; feet and legs white, or pale flesh color, toes five on each foot, middle one rather largest, second and fourth sub-equal, first and fifth much shorter than the others, though nearly equal to each other, nail white, feet and legs covered throughout with very soft white hair, which is scarcely perceptible without magnifying, length of hind feet to elbow .5; length of fore leg scarcely perceptible, except the foot, which is three tenths of an inch long. Whiskers white, and some of them extend to the ears. Eyes visible, $3\frac{1}{2}$ lines from the nose. Orifice of the ear very large, and curiously folded, being nearly 3 lines across. It was named by Dr. Dekay, to whom I sent it, *S. platyrrhinchus*, and he describes it as a *sub-genus*, OTISOREX. The whole fur of the animal is exquisitely soft and glossy, and he is the least and most delicate mammiferous quadruped I ever beheld. "Dental formula, $\frac{2}{2}$ incisors, and cheek teeth $\frac{18}{10} = 32$ teeth," (as decided by Dr. Dekay,) who "pays no attention to what are called false molars and true molars, as he believes in neither of them in the family of Soricidæ."

*10. Dr. Godman was, I think, mistaken in saying "the mole employs his flexible snout to thrust his food into his mouth by handing it backwards." A very little observation of the part will show its impracticability. But one fact I discovered which may be relied upon. After satisfying myself that he would not eat meat or corn, but would sooner starve, I rubbed some thick grease on the inside of an earthen vessel in which I had him confined, and he would entirely clean the surface, by sucking the grease *through his nostrils,* and this fact, witnessed with my own eye, induces me to believe, that the *rays* upon the star-nose mole may be used as feelers, and as means of creating suction to bring food, *via* the nostrils to the stomach. If it be objected that the mole's nostrils have no passage to the stomach, then it must have been conveyed by rolling the side of the upper jaw into the mouth, and thus making a tube into the mouth below the nostrils. But certainly the point of the nose or upper jaw does not bend in at all.

*11 and 12. I have obtained a specimen of each in Stratford, and have them in my cabinet.

*13. The black bear has been killed in Connecticut since my recollection, and according to Dr. Emmons, some are killed every year in Williamstown, Mass.

*14. Dr. Emmons, in his report, page 26, says: "the raccoon is not known to destroy small animals, and in a state of nature is supposed to subsist entirely on vegetables." This is a mistake; I have seen recently in Weston, a hen-roost built of stone, some seven feet high, and covered with a wooden roof, which the

Family CANIDÆ. The Dog Family.

15. Canis familiaris, Linn., Dog, introduced.
*16. C. Lupus, Linn., Wolf, Bridgeport.
*17. C. fulvus, Desm., Red Fox, common, O. L.
18. C. cinereo-argentatus, Gmelin, Grey Fox, *rare*, Fairfield County.
*19. C. decussatus, Geoffrey, Cross Fox, Stratford.
*20. C. argentatus, Sabine, Black Fox, Stratford.

Family FELIDÆ. Cat Family.

21. Felis maniculata, Linn., Common Cat, introduced.
*22. F. concolor, Linn., Puma or Panther.
*23. Lyncus borealis, Temminck, Canada Wild Cat, Southington.
*24. L. rufus, Harlan, Common Wild Cat, North Fairfield.

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raccoon had entered night after night, by pulling out a top-stone, and *taken fowls*, and several times could not get out where he went in; and his efforts to destroy the roof or eat through, were truly wonderful. Suffice it to say, that after destroying nearly all the fowls, he was at length taken in a trap and killed, much to the surprise of the owner; as it had not been suspected that a raccoon could be guilty of such mischief.

*16. Only three years since, a very large wolf was killed near Bridgeport by Mr. Moses Bulkley; and one ten years since in Newtown, by Mr. Aaron Glover.

*17. It is said by sportsmen here, that more than two hundred red foxes were killed in Fairfield county last year.

*19. From ten to fifteen specimens of the cross fox were killed in Fairfield county last year; and he is so called, because of the stripes on his back and shoulders, which taken together resemble a cross. This fox is generally larger than the red species.

*20. The black fox I once saw in Northford, and am well informed that one was seen some years since on Stratford Point; but this species is very rare in the eastern states.

*22. The *puma* or *cougar*, has at times been reported as killed in Connecticut, and I saw a fine specimen, said to have been killed in the northern part of the state, exhibited in Mix's museum some years since. Dr. Emmons says they are still found in St. Lawrence county, New York, where one man killed five with his dog and gun not many years since.

*23. The Canada lynx, as I am informed by Mr. E. C. Herrick, was trapped in Southington some four or five years since, and brought to New Haven for exhibition. See also description by Mr. Herrick, in the Am. Jour. of Science, Vol. XXXVII, p. 194.

*24. The common lynx or wild cat still inhabits this state, on the mountains of New Fairfield and Kent, and one has also been recently killed at Stonington in this state.

Family MUSTELIDÆ. The Weasel Family.

*25. Mustela Canadensis, Linn., the Fisher. ?

*26. M. Martes, Linn., Pine Marten. ?

*27. M. pusilla, Dekay, Little Weasel, Northford.

*28. M. fusca, Bachman, Brown Weasel, Northford.

*29. Putorius Noveboracensis, Dekay, New York, Ermine, Stratford.

30. P. Vison, Emmons, the Mink, common, O. L.

31. Mephitis Americana, Desmarest, the Skunk, O. L.

32. Lutra Canadensis, Richardson, Otter, Housatonic.

Family PHOCIDÆ. Seal Family.

*33. Phoca concolor, Dekay, Common Seal, Housatonic.

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*25. Dr. Godman supposes the *Fisher* to be nothing more than "an over-stuffed specimen of the common mink." But Dr. Emmons says—"the animal is found in the vicinity of Williamstown, Mass."

*26. Dr. Emmons adds to the above note, that the *pine marten* is found in the mountainous districts of Berkshire in that state; hence it is probable, the distance being small, they may both occasionally stray into Connecticut.

*27. The name of *M. pusilla*, is given to our little weasel by Dr. Dekay, because he has ascertained it to be a distinct species from *M. vulgaris* of Europe. Tail $\frac{1}{4}$ the length of the whole animal, 12 to 13 inches.

*28. *M. fusca* of Bachman, I have often seen and taken in Northford, and agree fully with Dr. Dekay, that it is a distinct animal from the preceding species, though they are nearly allied. Both species are common in Connecticut. Tail $\frac{1}{5}$ the length of the whole, usually about 12 inches total.

*29. I have a specimen of the New York ermine, or black weasel, in summer dress, taken in Stratford, $20\frac{1}{2}$ inches in length; head and body 13 inches, tail $7\frac{1}{2}$. This is the weasel which changes to pure white in winter, except the tuft of the tail. The other species remain unchanged. There is great discrepancy in the books on this subject, but this is the true history of facts as they are now known. I was well informed at the time, by a very respectable family in New Canaan, being myself then a resident in the place, that no less than seventy white weasels were counted by them in one gang, crossing the road in a westerly or southwesterly direction in the autumn of that year; and to my own mind it was satisfactory evidence that these animals, in some seasons at least, migrate southerly.

*33. No winter passes in which the common *seal* is not seen near the mouth of the Housatonic; and a few years since one was killed by a Mr. Curtis of Stratford, eight miles up the river. One which I saw taken alive at Guilford, when irritated disengaged a sort of thin mucus from the nostrils, in the same manner as a common cat when alarmed—rousing himself and making at the same time a grunting noise, like a kind of bark. And Dr. Dekay justly remarks, that "our common seal is uniformly dark slaty gray, unspotted, and therefore entirely a distinct species from the *vitulina* of Vampe:" length four feet.

*34. Phoca Grœnlandica? Mull., White Seal, Stonington.
*35. Stemmatopus cristatus, Dekay, Hooded Seal, Long Island Sound.

Order RODENTIA.

Family Castoridæ. The Beaver Family.

*36. Castor fiber, Harlan, Beaver, now extinct.
37. Fiber zibethicus, Desm., Muskrat, common, O. L.

Family Leporidæ. Hare Family.

38. Lepus Americanus, Sabine, American Rabbit, O. L.
39. L. Virginianus, Harlan, White Rabbit, O. L.

Family Muridæ. The Rat Family.

40. Arvicola xanthognata, Leach, Meadow Mouse, O. L.
*41. A. riparius, Ord, Marsh Campagnol, Stratford.
*42. A. Floridanus, Ord, Florida Rat, Wood Rat, Bridgeport.
*43. A. albo-rufescens, Emmons, White Rat, Stonington.

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*34. The *white seal*, commonly called the harp seal, is very rare, and has been seen only at Stonington a few times on the rocks. During the past winter, attempts were made to take him, but unfortunately the hunters went to the windward side of him, and though they came so near as to shoot at him while sliding off, he escaped. I have the information from J. H. Trumbull, Esq., of Stonington, who says, "his color was a dusky white throughout." I conclude, therefore, it must be the *Grœnlandica*. Mr. T. also remarks, "I have often heard our sealing captains from this place speak of the white seal as very rarely seen in the south seas, but never heard of it on our coast before."

*35. The hooded seal was taken at East Chester, a little west of Connecticut, a few years since, and most probably passed through our state to arrive there. Dr. Dekay gave a description to the New York Lyceum, which is before the public. Beside this, his being thus accidentally taken, is good evidence that other specimens exist in our waters.

*36. The *beaver* was once common here, from the fact that on all our large streams, nothing is more common than the names *Beaver Dam, Beaver Pond, Beaver Meadow*, &c.

*41. Of the *marsh campagnol* I have taken three specimens in Stratford.

*42. The *wood rat*, it is said by Mr. Thompson, (merchant in B.) "was brought to Bridgeport by vessel some years since, but it is believed was finally destroyed by the common brown rat, its mortal enemy." Godman and others supposed it once common here.

*43. Of the *white rat*, two whole families have been found at Stonington, as I am informed by Mr. Trumbull; and though I have not yet had a specimen, I am induced to believe it the *Arvicola albo-rufescens* of Emmons. Mr. T. describes it as about $\frac{2}{3}$ the size of the common brown rat, or *Mus decumanus*.

44. Mus Musculus, Linn., common House Mouse, O. L.
*45. M. agrarius, Gmel., Rustic Mouse, Northford.
*46. M. Rattus, Linn., Black Rat, Bridgeport.
47. M. decumanus, Pal. common, Norway Rat, O. L.
48. Arctomys Monax, Gmel., Wood Chuck, common, O. L.
*49. Gerbillus Canadensis, Desm., Jumping Mouse, Stratford.
*50. Sciurus Carolinensis, Gmel., Gray Squirrel, common, O. L.
51. S. Hudsonius, Gmel., Red Squirrel, common, O. L.
52. S. striatus, Klein, Striped Squirrel, common, O. L.
*53. S. vulpinus, Gmel., Fox Squirrel, rare, Northford.
*54. S. niger, Linn., Black Squirrel, Stonington.
55. Pteromys volucella, Linn., Flying Squirrel, common, O. L.
*56. Pteromys ? Red Flying Squirrel, Stratford.

Family HYSTRICIDÆ. The Porcupine Family.

*57. Hystrix dorsata, Linn., the Porcupine, Huntington.

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*45. Of the rustic mouse, I caught two specimens some years since in Northford, New Haven county, about a mile from any house. They answer the description as given by Godman, and are the same as the *Emmonsii* of Dekay, and *leucopus* of Richardson.

*46. The black rat has been seen at Stonington, and at Bridgeport, as I am well informed by naturalists who have seen it in both places.

*49. The jumping mouse has been taken at Stratford Point, at New Haven, and at Bridgeport. I have a fine specimen in my cabinet, taken this season in Stratford.

*50. I have a white squirrel in my cabinet, taken here, which I suppose a variety of the gray, being of the same size.

*53. The fox squirrel is rare. I have seen but one specimen in Connecticut, though I killed one in Georgia which weighed 2¾ pounds, and tail measured 16 inches. Ours are believed to be commonly a little less.

*54. The black squirrel has been taken at Stonington, and one is now in that borough domesticated.

*56. Several persons of the first respectability, in this and a neighboring town, have recently assured me that they have often killed a flying squirrel whose color is bright *red*, and the size much larger than the common flying squirrel. I have not had time since to obtain a specimen, but hope soon to be able to give some further account of it. It may however prove to be only a variety, but even that is new.

*57. The porcupine was killed a year or two since in Huntington, in this county, but was subsequently supposed to be one which had escaped confinement in Monroe a few months previous. According to Dr. Emmons's report, it is still found in Williamstown, a little north of us, and may easily straggle into Connecticut.

Order PACHYDERMATA.

Family Equidæ. Horse Family.

58. Equus Caballus, Linn., Horse, introduced.
59. E. Asinus, Linn., Ass, introduced.

Family Suidæ. Swine Family.

60. Sus Scrofa, Linn., Swine, introduced.

Order RUMINANTIA.

61. Bos Taurus, Linn., Ox, introduced.
62. Ovis Aries, Linn., Sheep, introduced.
63. Capra Hircus, Linn., the Goat, introduced.

Family Cervidæ. The Deer Family.

*64. Cervus Virginianus, Gmel., Deer, Waterbury.

Order CETACEA.

Family Balænidæ.

*65. Balæna Mysticetus, Pennant, Right Whale, Stonington.
*66. Physeter macrocephalus, Linn., Spermaceti Whale, Stonington.

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*64. A specimen of the deer, according to a notice in the New Haven Palladium, was last winter taken by Mr. L. F. Lewis, in Waterbury, and a pair of domesticated deer are now kept on Greenfield Hill by Dr. Bronson.

*65. The "*right whale*" was taken at Stonington a few years since, which yielded twenty seven barrels of oil, and another from the same gang was taken into Montauk, which yielded sixty barrels; and during the last summer six or eight whales were seen blowing within four miles of Stonington, as I am informed by J. H. Trumbull, Esq., of that place.

*66. The spermaceti whale, or blunt-headed cachalot, is described in the New Edinburgh Encyclopædia, under *cetology*, p. 559, as "found in Greenland and in *the seas that wash the shores of New England.*" Wright's Buffon, also, Vol. 4, p. 69, says—"the New England whale has a hump on the back," and this hump applies only to this species. Its distinctive character is, that "it has an elevated hump in place of the dorsal fin." Dr. Dekay also describes it as an inhabitant of New York state.

*67. Rorqualus† costatus, Dekay, Beaked Whale, Stonington.

Family Delphinidæ.

*68. Delphinus Delphis, Sea Porpoise, Long Island Sound.

*69. Globicephalus melas, Dekay, Social Whale, Bridgeport.

*70. Phocæna communis, Dekay, Common Porpoise, Long Island Sound.

*71. P. orca, Dekay, Grampus, Stonington.

It is matter of some astonishment, how little is to be learned from the books as yet before the public, on the subject of the *whales* and *dolphins* that inhabit the waters of the United States. Dr. Dekay has kindly furnished me with the *generic* and *specific descriptions of the last two families;* but as his report, now in progress of publication, will doubtless soon appear, I have deemed it for the present expedient that they should first come before the public in that splendid and most valuable work. No man is probably better acquainted with the species of these two fami-

*67. Of the beaked whale, it may be said that a specimen sixteen to eighteen feet in length, was taken in Raritan Bay in 1822, and hence we may infer that the east end of our Sound would be as likely to receive such an occasional visitor as that bay; especially as he is said to be "found in most parts of the Northern Atlantic."

*68. The *sea porpoise* is described as having forty eight teeth in each jaw. Dr. Dekay however describes it as having ninety two to ninety five in each jaw. I have a jaw specimen of this species which has ninety six teeth, that is, forty eight on each side. He is found throughout the Atlantic Ocean.

*69. A specimen of this animal was stranded near Bridgeport a few years since, an account of which will be found in the Am. Jour. of Science, Vol. xxiii, p. 301.

*70. Numbers of the common porpoise are taken in this town for the sake of the *oil*, which is usually from three to seven gallons. A captain of a vessel from this place assures me, that he once saw the mother and young of this species by her side, (the young about 3 feet in length, the old is usually from 4 to 6 feet,) the mother had caught a flat fish, and was evidently teaching the young one how to catch it. After taking it in her mouth, she threw it out forward with great force about six feet from her; and he adds that he saw her repeat this operation at least eight or ten times!

*71. This species is from 20 to 25 feet in length, and I have on several occasions met in Boston Bay and vicinity, what the fishermen called the *grampus*, and about this size, and as Dr. Dekay has given him a residence in the waters of New York, I infer that he may probably make us an occasional visit.

† "*Rorqualus* in the Norwegian tongue means whale with folds." See Nat. Lib. by Sir Wm. Jardine, Vol. 6, p. 125.

lies, which inhabit the waters of New York and New England, than Dr. Dekay. But he needs no praise from my pen, as his attainments in most branches of natural science are well known and highly appreciated throughout the literary world. This field is evidently a large one, and very much of it remains yet to be explored by future enterprising naturalists. As regards the *quadrupeds* of Connecticut, it is believed there are very few, if any, not named in the preceding catalogue. It is not very improbable, however, that we may discover some more species of *vespertiliones*, of *sorices*, and of *arvicolæ*. I intend soon to furnish a catalogue of the *birds* of Connecticut, having it already nearly completed, and more than half the species put up in my own cabinet.

Elm Wood Place, Stratford, Conn., 1842.

Art. VIII.—*Analysis of Meteoric Iron from Cocke County, Tennessee, with some remarks upon Chlorine in Meteoric Iron masses;* by Charles Upham Shepard, M. D., Prof. of Chem. in the Medical College of the State of South Carolina.

Having been informed by Mr. Edward C. Herrick that a specimen of meteoric iron existed in the museum of the East Tennessee University at Knoxville, I addressed a letter to President J. Easterbrook of that institution, desiring information upon the subject, and if possible, a fragment for analysis. The President was kind enough to transmit to me a specimen for examination, together with the following notice of its origin. "It is a portion of an irregular mass, which was given me about five years since. The mass, as you have been informed, was discovered in Cocke county. The proprietor resisted for some time, all importunities to discover where it was; believing it to be some metal of great value. I assured his agent that it was native iron, and probably meteoric. After he became satisfied of its character, many individuals examined it, in place. It was entirely insulated on the surface of the ground, and weighed about seven or eight hundred pounds. Specimens were obtained from it and dispersed through the country. It was my intention to have purchased and transported the entire mass to Knoxville, until I learned that Dr. Troost, geologist to the state, had obtained the refusal of it. He has since conveyed it to Nashville."

It turns out therefore, to be a portion of the mass described by Dr. Troost in Vol. xxxviii, p. 250, of this Journal. Having been presented by Dr. T. with several fragments, as illustrative of the portion in his hands, I found on comparing them with the specimen sent by President Easterbrook, that the latter differed very much from the former, in external appearance. Unlike to them, it was to a degree, free from the plumbaginous and pyritous admixtures with which they abound. It agreed with them however, in possessing a coarsely crystalline texture. Its proportion of nickel falls much below that quoted by Dr. Troost; but this is a circumstance which I have found to hold true in the Texas iron, wherein my experiments have proved the nickel to vary from 3.2 to 9.6 per cent. The specific gravity of the mass was 6.222.

I. Ten grains were treated with nitro-hydrochloric acid. The metal was rapidly taken into solution; but a blackish residuum remained. This was treated by itself, with heated nitro-hydrochloric acid for several hours. The quantity was thereby reduced; but a few black grains (of the size of fine-grained gunpowder) together with numerous shining scales, still remained in the fluid. These were well washed and dried. They weighed 0.01 gr. The acid solutions were mingled, and precipitated by ammonia, in large excess. The fluid stood along with the precipitate for six hours, at a temperature of nearly 100°. The peroxide of iron was then separated, and thoroughly washed for several hours with tepid water. The washings and the original ammoniated liquor were mingled and boiled; after which they were transferred to a glass bottle, and decomposed while hot by potassa. The clear liquid was separated after twenty four hours, by filtering (the hydrosulphate of ammonia, when added to it, produced no change of color). The precipitated oxide of nickel was ignited, and weighed 0.6 gr. The peroxide of iron after ignition, weighed 13.4 grs. We have then,

Iron, - - - -	9.380 =	93.80 p. c.
Nickel, - - - -	.466 =	4.66 p. c.
Undissolved, - - -	.010 =	0.10 p. c.

A second and parallel analysis was conducted upon 30 grs., the results of which were as follows:

Peroxide of iron,	40.30 =	Iron,	28.210 =	94.033 p. c.
Protoxide of nickel,	1.68 =	Nickel,	1.333 =	4.444 p. c.
Undissolved,	0.03 =	Undissolv'd,	.030 =	0.100 p. c.

The undissolved matter from both the analyses was examined by the microscope. It was principally in soft black grains, along with which were a few brilliant scales of graphite. Both the grains and the scales were attracted by the magnet. On grinding them in a mortar, they gave a brown powder, in which little particles of metallic iron were felt beneath the pestle. The powder was then treated with nitro-hydrochloric acid, whereby the iron was dissolved out, leaving behind a fine, blackish brown powder.

II. Fifty grains of the meteoric iron were now subjected to the following analysis. Distilled water was boiled upon the iron for a few minutes. A portion of the fluid, separated from the iron, gave with nitrate of silver no precipitate:* another portion gave with chloride of barium a slight precipitate. The iron was then treated with nitro-hydrochloric acid. The action of the acid ceased after a few hours, numerous flakes of the iron remaining in the flask, as if insoluble. On the application of heat however, the action was renewed. More acid was subsequently added, and the digestion continued, until the solution was apparently at an end. The black grains and shining scales were separated, washed, dried, and rubbed in a mortar as above. The blackish brown powder (having metallic iron intermixed) was treated with hydrochloric acid: a brisk effervescence from the evolution of hydrogen, immediately ensued. When the action had ceased, the fluid was decanted, and the residuary, blackish brown powder transferred to a small platina capsule, in which it was ignited for a few moments with exposure to the air, in order to burn off the free carbon. It was then ignited to low redness with twice its weight of nitrate of potassa. Water was boiled on the fused mass: a portion of the blackish powder still remained. The solution was colorless, showing the absence of chromium. Nitrate of silver produced in it a pale, yellowish precipitate of phosphate of silver. The residuary brown powder was now ignited for several minutes with dry carbonate of potassa; water was boiled upon the same; the solution was decomposed by nitric acid, and then evaporated to dryness, after which the

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* I am informed however, by Dr. Troost, that he has detected chlorine in some portions of the mass in his possession.

addition of water brought flocks of silicic acid into view. The results of this analysis give

Iron,	- - - - - -	93.80
Nickel,	- - - - - -	4.66
Carbon, Silicon, Phosphorus,	along with grains of iron and nickel alloy,	0.10
Oxygen, sulphate of iron, sulphur, moisture and loss,	-	1.44
		100.00

Charleston, February 9, 1842.

Since my return to New Haven, I have paid some attention to another specimen of meteoric iron from the same mass with the above, and which was kindly afforded me by Dr. Troost. On breaking it to obtain a fresh fracture, the regular crystalline structure showed itself on the largest scale. The clean surfaces were intersected by layers of brilliant magnetic iron-pyrites, varying in thickness from one sixteenth to one fourth of an inch, whereby a series of trihedral and rhombohedral areas of various sizes were produced. These regularly inclosed spaces were mostly black, from the diffusion of a sooty form of carbon between the plates of the meteoric iron. The contrast between the areas and the separating layers of pyrites was consequently rendered more striking. Besides the distribution of the pyrites in plates or veins, it also occurs in balls and almond-shaped masses, sometimes half an inch or more, in thickness. The structure of these is concentrically laminar, the laminæ being often separated by iron and carbon. The pyrites forms nearly one sixth of the mass. Dr. Troost presented me also with several loose balls of the shape of the pyrites masses, which to the eye seem composed of little else than carbon, concerning which a few remarks will presently be subjoined. None of these balls are found imbedded in the specimen I am more particularly describing.

If we except the bright projecting edges of the pyritic veins, the *Widmanstättian* figures produced by etching with dilute nitric acid on polished surfaces in directions of cleavage in this iron, are by no means striking. Little channels and waving striæ, bright at bottom and dull at top, are indeed brought into view; but these are so minute and irregular as to require the use of

a microscope before their true character is detected.* If however, cross sections to the above surfaces are polished and etched, we then see the delicate, silver-white lines, which are so common in other meteoric irons. As this iron is cleavable into layers of extreme tenuity, I selected a number of layers whose edges were the brightest on these etched surfaces, for analysis; my inquiry being chiefly to ascertain whether the ratio of the iron to the nickel was the same here, as in average portions of the mass. I was satisfied that it contained no greater per cent. of nickel than I had found in the analysis made at Charleston.

In polishing some of the carbonaceous balls above alluded to, minute grains of pyrites were rendered visible; and others still smaller, which had a more silvery whiteness.† A small fragment was crushed under water in a mortar, and yielded white malleable grains, similar to tin. Portions of the mass were then acted upon by the blowpipe along with carbonate of soda, when the most satisfactory evidence of the presence of tin was afforded. I found also that (by treating these carbonaceous masses with nitric acid and subsequently igniting with potassa) they contain silicon and magnesium in decided proportions, with traces of aluminium. Their shape and mode of occurrence served to suggest an analogy they sustain to the imbedded grains of olivin in the Pallas iron of Siberia, and the Otumpa iron of South America, the difference in the case being, that in the Tennessee iron no oxygen was supplied for the combustion of the silicon, the magnesium, the aluminium, and the iron.

It may not be out of place to add here, a mode of detecting magnetic iron in meteoric irons, which was suggested by an observation of Mr. Abbot, the artisan who polished a face of the Texas mass in the cabinet of Yale College. He inquired of me the reason why, in the process of polishing, the dust abraded, especially when rendered pasty by oil or water, should arrange itself in lines so much resembling the outline of mountain ranges. Suspecting the phenomenon to be due to lines of magnetic iron in the mass, I scattered some pulverized magnetic iron ore on a slab of the polished iron, the half of whose area was etched, and found on giving

* Similar results were obtained on a cleavage surface of the Guildford, N. C. meteoric iron.

† Dr. Troost found their composition to be carbon 46.5, iron 3.0, and loss .5 in 50 parts. See this Journal, Vol. xxxviii, p. 253.

it a slight jar that the powder arranged itself in directions coinciding with the Widmanstättian figures, and that a portion of it maintained its adhesion, even though the surface was held in an inverted position. No other meteoric iron in my possession exhibits a similar property. I have since ascertained by a solution of the Texas iron, that it contains magnetic oxide of iron.

On Chlorine in Meteoric Iron.

The detection of chlorine in meteoric iron was a discovery of Dr. Charles T. Jackson, of Boston.* It was made upon a meteoric mass found at Claiborne, Ala. (See this Journal, Vol. xxxiv, p. 332.) The mass examined weighed twenty eight ounces, and so rich was it in chlorine, that Dr. J. considered it as an original ingredient of the meteorite, and conjectured that it would be found in other meteoric bodies, advancing at the same time an ingenious hypothesis founded on its presence in them, for their incandescence on entering our atmosphere.

For a time, I was inclined to suspect that the mass examined by Dr. J. had acquired its chlorine from the chemical trials it might have undergone prior to its reaching his hands; for in his paper we are told, that it had been supposed to contain silver. This conjecture of mine was put to rest however, on my analysis of the meteoric iron of Buncombe, N. C., (see this Journal, Vol. xxxvi, p. 81,) inasmuch as I met with the same element in that mass, and more lately in that of Guildford (see this Journal, Vol. xl, p. 369), in the same state.†

The observations which I am about to detail however, have greatly shaken my confidence in the extra-terrestrial origin of chlorine in these masses.

During the last summer, a mass of cast-iron kentledge of the usual size and shape (i. e. a right square prism of about twenty

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* In a published report of the British Association for 1839, (Abstracts, &c. p. 54,) an abstract of a communication of mine on meteorites is given, with the omission of Dr. Jackson's claim to the discovery of this element. If the original papers from which the Transactions are made up are preserved by that body, it will appear that I was by no means guilty of overlooking the merits of Dr. J. in this particular.

† The external aspect of several specimens of meteoric iron preserved in the fine collection of the British Museum, led me to conjecture that they also included chlorine; while I have mentioned in the foregoing account of the Tennessee iron, that Dr. Troost has found it in that remarkable mass.

inches in length and of about one hundred and fifty pounds weight) was accidentally discovered buried in the mud, near the end of Long wharf in this harbor. It was supposed, from its external aspect as well as the place in which it was found, that it must have been in the situation mentioned, for a long time. On fracturing it with a hammer, an internal structure was brought to view, so peculiar as to lead many persons to suspect that it was not cast-iron, notwithstanding its form and the two holes near each end, which generally characterize kentledge iron. It was taken to the hardware and iron store of Messrs. Sherman & Atwater, where, as Mr. Sherman now informs me, it was viewed as a curiosity by great numbers of persons, many of whom did not appear to have been satisfied that it was iron, until the opinion of Mr. B. Silliman, Jr. had been obtained upon the subject. In passing the store during the summer, my notice was also called to the subject by the store-keeper, who presented me with a fragment of the mass of at least fifteen pounds weight. I viewed it with interest at the time, solely because it afforded the marks of having suffered an apparent change of molecular structure—the coarsely crystalline and foliated texture having, as I supposed, replaced that of the granular which is common to cast-iron.

I detached a fragment of several ounces in weight from the mass, and took it with me to Charleston, where it was placed in my collection by the side of a specimen of meteoric iron from Buncombe, N. C. (the latter sealed up under glass). I observed in the winter, that the New Haven iron had begun to assume the same deliquescent and efflorescing appearance as the undoubted chlorine-meteoric iron: but I postponed the examination for chlorine until my return here, where it might be conducted in a more satisfactory manner. On recurring to the original mass, my surprise was much increased at finding its surface in many places, nearly covered with spherical, blebby shells, (some of which were as large as peas,) exactly analogous to those which form on the chloridized meteoric iron. Two or three of the globules were detached and thrown into warm, distilled water, the solution filtered and treated with nitrate of silver, whereupon an abundant precipitation of chloride of silver ensued. I next detached pieces of the clean iron from parts of the mass more internal, and boiling them in water, obtained a similar precipitate of chlorine, though

less abundantly than in the first experiment, but so decided on the whole, as to leave no doubt of the thorough permeation of the mass by the element in question.

Aware that this fact by itself could only throw a doubt upon the foreign origin of chlorine in meteorites, since the kentledge mass had been in a situation quite different from that in which meteoric irons have been found, I was happy in having it in my power also to examine what I suppose to be an artificial carburet of iron, and which came into my hands during the winter in the following way.

Dr. A. C. MATHIESON, of Charleston (then a student of medicine in the College), handed me a small, tabular fragment of supposed iron-ore, found in the edge of the middle country of the state of South Carolina.* It was taken from a depth of several feet from the surface of the ground, on a sandy hill-side, where other specimens were believed to exist. It was sent to me by the proprietor of the land, under the impression that it denoted the existence of an iron-mine. It appeared to me from its uniform thickness, foliated-granular texture, as well as color and hardness, to be a fragment of some cast-iron utensil.

The superficial area of the mass was about two inches. Its thickness was one third of an inch. It presented fresh fractures on all the sides, as if it had recently been broken from a larger mass. The upper and under sides were invested with a blebby, ochraceous covering of nearly one line in thickness. A fresh portion, detached, and cleared of the scaly ochre, gave a specific gravity=7.308. It was found on analysis to be a carburet of iron. Its hardness was sufficient to scratch glass. It was reported upon accordingly, as being most probably a mass of cast-iron, which had accidentally been buried in the soil.

Having detected chlorine in the New Haven cast-iron, it occurred to me to subject the fragment just described to a similar examination. It was therefore treated with warm water and nitrate of silver, when a copious precipitate of chloride of silver made its appearance. I was now led to suppose that any piece of iron which undergoes rusting in the soil, would afford chlorine. A piece of sheet-iron, nearly consumed by rust, was found buried

* The precise locality I do not now remember, but it was at least seventy miles from the coast.

in the soil on land, at no great distance from my house. Its surface exhibited in several places the blebby efflorescences which I expected to find, and these on being removed and boiled in water afforded undoubted evidence of chlorine.

It will be easy to prosecute this inquiry into a greater number of details, and I shall follow it up still farther, as opportunities may offer; but I think the foregoing cases are calculated to place the meteoric origin of chlorine, in at least a doubtful point of view.

The sources of chlorine to the mass of kentledge which was buried in the harbor were undoubtedly the chlorides of sea-water; while in the other instances, the chlorine may be attributed to that universally diffused haloid salt, the chloride of calcium (muriate of lime). The decomposition in both cases, may be the result of electrolytic action, in which carbon and iron are the decomposing elements, the latter being the positive electrode, upon which the chlorine is evolved, and with which it combines as fast as the electrolysis proceeds.

It is easy to see that the composition of meteoric irons, and the situations in which they are frequently placed, in and upon the soils of our earth, might enable them to obtain chlorine in a manner similar to that supposed in the two last mentioned cases.

Additional Remarks on the New Haven mass of Kentledge Iron.—A coarse crystalline texture was developed throughout the prism, if we except about one and three fourths of an inch upon one side, in which a sub-porous, fine granular structure exists; but near its line of junction with the coarser texture, an insensible gradation between the two structures is visible. The crystalline portion is analogous to that of the coarsely meteoric irons of North Carolina and Tennessee. When first broken, its structure reminds one most forcibly of metallic antimony; but after a few months exposure to the air, the tendency to oblique tetrahedral cleavage becomes more striking. When a large fragment of it is broken so as to present a fracture across the laminæ, the following structure becomes visible: two sets of laminæ appear, which alternate with each other in a regular order; the thickest of these are about one tenth of a line, the thinnest one twentieth of a line. The latter are foliated perpendicularly to the breadth of the laminæ; the former in coincidence with their breadth. We moreover observe in any considerable fragment, that layers of both kinds frequently intersect the main series at angles of 60°

and 120°, in which directions the cleavages occur which lead to the tetrahedral and prismatic forms. When a fragment is thrown into nitric acid, a cross fracture of the main layers shows mosaic markings, composed of bright edges and intervening depressions, similar in some respects to the Widmanstättian figures on polished surfaces of meteoric iron. The graphic character is heightened also by the more perfect reflexion of light from the vertical laminæ of the thinner plates, than from their edges in the broad layers, which latter instantly become a dull gray. The decomposition of the acid soon ceases, unless heat is applied, when it goes on as before, the graphic structure remaining visible until the mass is dissolved. The figures on etched meteoric iron may in part also be attributable to mechanical structure, instead of depending solely on differences in chemical composition, as heretofore imagined.

I must remark also, that the broad cleavage surfaces of the cast-iron exhibit under the microscope, an exceedingly delicate, striated appearance, the striæ running constantly in one direction and being occasionally crossed by interrupted lines (either raised or depressed) of a larger size, at an angle of 60° and 120°; while from these last, other short lines or dots project at an angle of 90°, giving rise to marks resembling the capital letter F or E.

The specific gravity of this iron is 7.57. Its hardness is sufficient to scratch glass. It is easily shattered into fragments by a blow of the hammer; and on exposure to the air exfoliates almost spontaneously into thin laminæ. When dissolved in nitric acid, the carbon is left undissolved in a fine powder, showing that it was chemically combined with the iron, in the condition of steel.

The structure and composition of this iron (considered along with that from South Carolina) appear to me to afford good reasons for concluding, that both the chemical composition and mechanical structure of meteoric iron undergo alteration by contact with our earth, and that such modifications deserve to be considered before we attempt to employ either the one or the other as a characteristic of such bodies, or as the grounds of a theory to account for their origin.

New Haven, May 19, 1842.

ART. IX.—*On Washingtonite (a new Mineral), the discovery of Euclase in Connecticut, and additional notices of the supposed Phenakite of Goshen, and Calstron-baryte of Schoharie, N. Y.*; by CHARLES UPHAM SHEPARD, M. D., Professor of Chemistry in the Medical College of the State of South Carolina.

THE first allusion to the substance in question is found on p. 156, Vol. I, of my Treatise on Mineralogy (1835), where it is described as occurring in broad, laminated, imperfectly hexagonal masses at Washington, Conn., imbedded in a vein of quartz in mica-slate. It was again referred to (1837) in my mineralogical report of Connecticut, p. 146, as existing in rolled masses of quartz among the diluvium of South Britain. In 1838, two other localities were discovered by Messrs. T. S. GOLD and W. W. RODMAN, then pupils of mine in mineralogy. That found by Mr. GOLD was in Litchfield, while that by Mr. RODMAN was in Westerly, R. I. Notices of these localities are contained in Vol. xxxv, p. 179, of this Journal, by these gentlemen respectively.

A recent examination of this mineral leads me to think that it is better to bestow a new name upon the American mineral, than to continue to associate it with Crichtonite, from which it so plainly differs in several important particulars, or even to bring it under the Axotomous iron-ore of MOHS, to which it is as little similar. I have therefore designated it from its first discovered repository, the town of Washington; and if from the frequent repetition of this name in the American union, the appellation be thought deficient in signification, it commends itself at least, on the ground of patriotism.

Fig. 1.

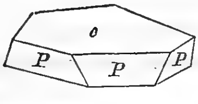
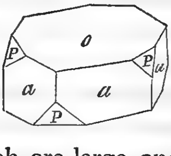


Fig. 2.



Description.—The crystals, which are large and remarkably well formed, are represented in figures 1 and 2; to which also may be added, the regular six-sided table.

Primary form, rhomboid: P on P=86°, as determined by the reflective goniometer, on varnished planes. Plane *o* the most

shining, P the least brilliant. The crystals, fig. 1, from Westerly, R. I., often yield to cleavage parallel to P with much perfection, affording faces more brilliant than any of the natural planes of the crystals. Crystals from Litchfield sometimes manifest a tendency to cleave parallel with *a*. No cleavage in the direction of *o* unless through the intervention of quartz. Fracture rather uneven. Lustre imperfectly metallic. Color iron-black: the fracture iron-gray. Streak the same, but lighter. Hardness=5.75. Gravity=4.963 from Westerly, 5.016 from Litchfield.

Before the blowpipe, infusible; but changes to a grayish black color. Unmagnetic before and after ignition. With borax, it fuses with effervescence into a clear, green glass, with a shade of yellow. With salt of phosphorus, it dissolves, forming an opake, orange-yellow glass, which on cooling, passes to an opake pearl-white. Its powder is decomposed (without evolution of chlorine) by long boiling in hydrochloric acid; an abundance of titanic acid separates from the solution, and the clear fluid after neutralization by ammonia and precipitation by succinate of ammonia, yields with carbonate of potassa a slight precipitate of carbonate of manganese. It may therefore be regarded as some titaniate of protoxide of iron, with a small proportion of oxide of manganese.

It is readily conceded that the mineral here described is not crystallographically shown to be distinct, in any essential manner, from the Axotomous iron-ore of Mohs, or from the Crichtonite (including Ilmenite): indeed it appears most probable that all these minerals are not only identical in their angles, but are isomorphous with Specular iron. If they are specifically distinct, indications of such differences may be looked for in the modifications of their primary forms, in cleavages, and in lustre: while essential differences will doubtless be found in specific gravity and hardness. The disagreements in secondary forms and cleavage are obvious from the description above given; those in lustre, color and streak cannot fail of striking any one, who compares the different substances with each other. The specific gravities may be judged of, from the following comparative table:

Axotomous Iron-ore of Mohs.

From Gastein, Salzburg,	G=4.661, Mohs.
	4.723 4.730, Breithaupt.

From Schwarzenberg, Saxony,	4.718,	Breithaupt.
From Arendal, Norway,	4.721,	do.
From Fredericksvairn, Norway,	4.735,	do.

Ilmenite.

From Ilmen, . .	G.=4.766 4.808,	G. Rose.
Do. do. . .	4.805,	Breithaupt.

Washingtonite.

From Westerly, R. I., . .	G.=4.963,	Shepard.
From Litchfield, Conn., . . .	5.016,	do.

Concerning the comparative hardness of these minerals, I can only state at present that the Washingtonite is harder than the Axotomous iron-ore.

The beautiful crystals from Amity and Monroe, Orange county, N. Y., belong to the species Axotomous iron-ore. The Washingtonite is also found at Goshen, Mass. along with spodumene, in thin foliæ.

Euclase in Connecticut.

This rare mineral is found in its gangue (for the first time ever observed) at the topaz and fluor vein of Mr. Lane at Trumbull. It occurs in thin, transparent, yellowish-white tabular crystals, lining cavities in a silvery white mica, and sometimes imbedded in a dark purple fluor.

Supposed Phenakite from Goshen, Mass.

A new examination of the specific gravity of this mineral* satisfies me that it is not Phenakite. Its gravity=2.75 . . . 2.76, which is too low for Phenakite, and slightly superior to Beryl. It also slightly exceeds in hardness, this last mineral.

Calstron-baryte.

I have lately examined new specimens of this mineral, with results so various in regard to the carbonates present, as to lead me to consider it a mechanical mixture of heavy spar, strontianite and calcite, and therefore not entitled to be considered as a mineralogical species.

New Haven, July 25, 1842.

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* See this Journal, Vol. xxxiv, p. 329.

Art. X.—*Abstract of the Proceedings of the Twelfth Meeting of the British Association for the Advancement of Science. Condensed from the Report in the London Athenæum.*

The twelfth meeting of the Association was held at Manchester, commencing June 22, 1842.

During the past year, grants for scientific purposes have been made to the amount of £1449 17*s* 8*d*. For the coming year grants for similar purposes, amounting to £3339 5*s*, were recommended by the General Committee.

On taking the chair at the General Meeting, Lord *Francis Egerton* delivered an interesting and eloquent address, comprising a review of the doings and prospects of the Association.

The next meeting will be held at Cork, in August, 1843.

Sect. A. *Mathematical and Physical Science.*

The following reports were presented to the Section.

Report of the Committee for the reduction of the Stars in the Histoire Céleste. "I have the satisfaction of reporting that the whole of the stars in the *Histoire Céleste* have been reduced, agreeably to the method proposed: those only being omitted for which there are no tables of reduction: and that there is now remaining, of the grant for this purpose, the sum of £9 which will not be required in the further prosecution of this portion of the work. But the main object of this undertaking will be defeated, if the catalogue be not printed for general use and information. The number of stars reduced is upwards of 47,000; and I have caused an estimate to be made of the expense of printing 500 copies in an octavo form. And it appears that the cost of paper and printing will be about £415, but that 1000 copies will cost £100 more. There is, however, another expense which must be taken into the account, which is the copying of the catalogue, in a proper order for the press and the correction of the press during the printing, which I apprehend will be £60 or £70 more. Taking the whole of these estimates together, it would appear that 500 copies would cost about £500, and that 1000 copies would cost about £600. Should the British Association decide on the printing of the catalogue, I would draw up

a statement of the method pursued in making the reductions, together with such other remarks as might be requisite. This probably would not add another sheet to the work.—FRANCIS BAILY.

"June 16, 1842."

Report of the Committee on the British Association Catalogue of Stars. "I have the honor to report on the subject of this Catalogue, that the calculations of the places of the stars, with the annual precessions, secular variations, and proper motions, together with the logarithms of the requisite constants, are completed for nearly 8300 stars, which is about the number originally contemplated: that the same are fairly copied out for the press: and that the construction of the table of synonyms is now in progress, two thirds of which are already completed: that the whole of the sum granted at the last meeting of the Association has been expended, and that a further sum of £25 will be required for the completion of some of the above stars in peculiar portions, and for the final completion of the synonyms: that the above sum of £25 is all that will be wanting in future, as Mr. Farley (the principal computer and superintendent) has undertaken to complete the work, ready for the press, without any further remuneration, and which will be ready for delivery in a few weeks. Under these circumstances, I have caused an estimate to be made of the expense of printing the same: and I find that the cost of paper and printing 500 copies in quarto, will be about £550, but that 1000 copies will cost £150 more. It will be requisite, however, to employ some one to correct the press, and to superintend the arrangement of the work, which will add to the expense here mentioned. A pretty large preface will be requisite, explanatory of the mode adopted in bringing up the several stars to the given epoch, and of various circumstances connected with the investigation, as well as descriptive of the method of using the Catalogue in its present form. But on these points I am willing to render any assistance in my power.—FRANCIS BAILY."

Report of the Committee for the reduction of Lacaille's Stars. "A committee having been appointed, consisting of myself, Mr. Henderson and Mr. Airy, for the purpose of effecting a reduction of Lacaille's stars, I have the pleasure to report, that under the superintendence of Mr. Henderson, the whole of that work is now completed, and the resulting Catalogue, being arranged in order of Right Ascension, is fairly written out and ready for the

press. The total number of stars reduced and catalogued, is about 10,000;—the sum of £105 remaining of the original grant unappropriated; which the committee recommend to be applied, (with such additional grant as may be needed,) to the printing and publication of the catalogue, without which it is evident that little or no benefit can result to astronomical science from the work so accomplished. With the catalogue, and forming an introduction to it, an account of the process pursued in the reductions, the constants used, and all other matter needful for a complete understanding of the work, ought also to be printed; and should it be the pleasure of the Association to order the publication, will be furnished by Mr. Henderson. The estimated cost of the publication so recommended, may be roughly stated at about £250, for printing, paper, &c. of 500 copies of the catalogue and introduction.—J. F. W. Herschel."

The President observed, that the discussion and publication of these observations upon the stars of the southern hemisphere, originally made by M. de Lacaille, now possessed an increased interest in consequence of the recent observations of Sir John Herschel, prosecuted at precisely the same locality, thus furnishing two series of observations upon the same stars at epochs separated by a very considerable interval of time.

Mr. W. Snow Harris reported on *the Meteorological Observations made at Plymouth* last year. He stated that at the close of 1842, he should be able to revise (and bring to the next meeting of the Association) the results of the series of meteorological observations continued hourly, night and day, without material interruption, during ten years. He now submitted only a general discussion of five years' observation of the barometer during the years 1837 to 1841, both inclusive, and some observations and experiments on the wind, made with Prof. Whewell's anemometer. The observations were made at a height of 75 feet above the level of the sea, and were reduced to 32° Fahr. He exhibited a chart, showing the lines resulting from the means in each of these years, and also the mean of the whole five years, and noticed the surprising coincidence in the general character of all these lines, and the very few and small deviations they presented—a remarkable result, considering the frequent atmospheric disturbances to which these latitudes are liable. The mean pressure of the six years corresponded with that already obtained.

The line of mean pressure occurred between the hours of 1 and 2, and between 7 and 8, A. M.; and again between 12 and 1, and between 6 and 7, P. M. The hourly *maximum pressure* was at 10 o'clock, morning and night; being, with only one exception, the uniform result for six years. The hourly *minimum pressure* occurred at 4, A. M. and P. M., being the uniform result for six years, without any exception. The line of mean pressure was crossed four times in the 24 hours; and thus was realized, in the midst of atmospheric disturbances of very considerable amount, that effect, termed *horary oscillation*, which was first observed by Baron Humboldt, in tropical climates. Mr. Airy, to whom these observations were submitted, seemed to think, that but little now could be effected by continuing them after the close of this year. There had been 48,000 hourly observations on the atmospheric pressure, and 87,000 hourly observations on the temperature: and he trusted these would not be preserved merely in the perishable form of manuscript, but placed at the disposal of the scientific world. After explaining the construction of Whewell's anemometer, he said, that when the pencil tracing the integral effect of the wind, moved at the rate of one tenth of an inch per hour, the current of air at the same time moved at a mean rate of eleven feet per second. He (Mr. H.) had, by means of this instrument, endeavored to arrive at something like an approximation to the velocity and direction of what he believed would amount to a *trade-wind.* He had a table of results which gave the mean velocity of the wind, in feet per second, for each month of the year, viz.

		Feet per sec.			Feet per sec.
April,	-	13.	October,	-	15.29
May,	-	12.6	November,	-	14.96
June,	-	10.9	December,	-	12.54
July,	-	9.	January,	-	12.76
August,	-	12.87	February,	-	13.97
September,		15.42	March,	-	14.63

So that the mean velocity of the wind during one year, (leaving the direction out of the account,) was about nine miles per hour. If the mean velocities arrived at in this table were diminished and made proportionate to the whole length of the wind, we should then have something like a general idea of the velocity of the aerial current, as deduced from observation and inquiry.

Thus according to Mr. Whewell's method of taking the observations, (which he was persuaded was the only true method,) in the latitude of Plymouth, they had something like a trade-wind, setting in from southerly to northerly points of the compass at a mean velocity of 4½ to 6 miles per hour. This was something like a definite result in meteorology; for no person before had ever attempted to discover the direction and velocity of the wind in its rate per hour, setting in a given direction.* In these statements he had been dealing only with mean results.

Mr. Howard hoped that Mr. Harris would not think of discontinuing these observations until at least the cycle of 18 years had been completed.—Col. Sykes believed that the hours of maximum and minimum mean pressure observed by Mr. Harris at Plymouth, would be found nearly, if not exactly, the same as those observed in India at an elevation of 2000 feet above the sea, and those observed in Mexico, by Humboldt, 10,000 feet above that level.—Col. Sabine said, he had that morning received a very important letter from Prof. Wheatstone, containing a proposal to make, for the Observatory at Kew, an apparatus which should record the operations of all meteorological instruments so as to effect a great saving of cost. One of the instruments was for measuring the force and direction of the wind, and was capable of being sent up in captive balloons, so that the currents, to a height of 8,000 or 10,000 feet, might be carefully examined. All attempts to make self-recording thermometers, barometers, &c. by mechanical means, have hitherto failed, because the mechanical force exerted by the rise of the mercury in the tubes, is insufficient to overcome the friction of the attached mechanism, and only very inaccurate indications can be obtained. The principle however, (observes Mr. W.) which I employ in my meteorological telegraph, viz. the determination (by means of a feeble electric current) of any required mechanical force by the mere contact of the mercury in the tube with a fine platina wire, enables all these difficulties to be overcome. I propose, therefore, that such an instrument, the cost of which I estimate will not exceed £50, shall be constructed under my direction for the Richmond Observatory. If, after a few months' trial at the Observatory, it shall be found

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* See Prof. Loomis's conclusions regarding the progress of the wind at Hudson, Ohio: this Jour. Vol. 41, p. 320.

to succeed, as I confidently expect it will, a great impediment to the advancement of meteorological science will be removed. Persons in almost every locality may be found who would not object to devote a few minutes per day to prepare such an instrument for use, but who would find it impossible to give the requisite attention to make hourly or half-hourly observations themselves.—Col. Sabine said, Mr. Bache, of Philadelphia, has requested me to explain the reasons which have prevented him from completing the Report on the Meteorology of the United States, which has been first called for, and which at the Newcastle meeting, Mr. B., being then present, was requested to prepare. But the task of providing funds by private subscription in the U. S. for the support of the system of magnetical and meteorological observations recommended by the Association, (which is elsewhere provided for as a national work,) has been undertaken by Mr. Bache, in addition to that of superintending its establishment and progress. Being thus occupied, Mr. B. has found himself unable to devote the necessary time and thought to the Report.

Sir J. Herschel read a *Report on the great co-operative system of Magnetic and Meteorological Observation*, which three or four years ago was commenced at the instance of the British Association. After noticing the vast increase of the surveys and observations, owing to the number of foreign establishments entering into the concerted plan, the Report referred to the Antarctic Expedition, taking it up where the Report of last year left it, at Hobart Town in 1840. Capt. Ross observed the November term (for observations) in 1840, at the Auckland Isles. On leaving those isles, his adopted course led him between the two southern magnetic foci. It seems probable that he was still to the eastward of the present locality of the greatest intensity. The full import of the observations made in this voyage is not yet known, but it is understood that intensities have been observed by Capt. Ross 2½ times greater than the minimum observed by him near St. Helena, on the outward voyage; and that the general aspect of the intensity observations would appear to place the centre of the principal isodynamic oval in a latitude somewhat exceeding 50° South. The nearest approach to the magnetic pole was in lat. 76° 12′, long. 164° East, the dip being 88° 40′. The intensity here was found to be less than in 47° South. The Admiralty, (who had rendered every service to these inquiries,) had

placed under the care of Col. Sabine the observations made on board each ship, the results of which were most satisfactory, as regarded the practicability of making accurate observations at sea; for out of 647 observations of this kind made between London and the Cape, on board the *Erebus*, one only had been declared doubtful, while the observations taken by both ships exhibited a steady accordance that could not be accidental, and might well be called beautiful. From these it would appear, if earlier observations are to be relied on, that the line of least intensity, in successive meridians, is travelling rapidly northward. The term of November, 1840, had been kept (by Capt. Ross) at the Auckland isles; those of May and June, 1841, at Van Diemen's Land; that of July, at Sydney; the four succeeding terms had been kept in New Zealand. From a letter from Capt. Ross, dated Nov. 22, 1841, it appeared that the expedition was to sail the day following, to resume the investigation: it was his intention to traverse the isodynamic oval, surrounding the focus of greatest intensity, supposed to be in lat. 60° S. long. 235° E.; commencing in long. 210°, and lat. 52° or 53° S., and steering thence directly to the edge of the ice-pack, to make, on reaching it, for the point where the first year's exploration of the new continent (of Victoria) had terminated, and to pursue that barrier; the working out of which intention might of course involve another winter, spent within the Antarctic zone. Should it be otherwise, we might expect ere long to hear of its arrival at the Falkland isles; but in the other alternative, another year would elapse without any further tidings of the Expedition. As to *British and foreign observatories*, the British and Indian stations, except that at Aden, as well as the chief continental ones, had long been in full activity. The Russian government has been pre-eminent in the aid given. Supported by M. Cancrin, Minister of Finance, as well as aided by the funds placed at his disposal by Prince Mentchikoff, M. Kupffer had brought into activity magnetic observatories at Kasan, Barnaoul, Nertschinsk, and Catharineburg. He had also effected the re-erection of observatories at Tiflis and Nicolayeff, and the erection of a new one at Moscow, under the care of Count Strogonoff, curator of the University of that city. These operations, conducted by every European power, had occupied much time; the original term granted by our own government and the East India Company expired in

the current year, just when the arrangements were completed over a great portion of the world, and the fruits were beginning to be gathered in. Accordingly, application was made by the President and Council of the Royal Society, for their continuation for another period of three years, to terminate in 1845; and at the same time it was officially stated on the part of the Russian government, that the observatories in that empire should be kept up as long as the British ones, Baron Brunow stating, that this extension was the shortest term adequate to obtain results to repay the outlay. The British government gave an unhesitating assent to the continuation of the present scheme for three additional years. For this new period the past had been an excellent preparation; all improvements that experience could suggest would be adopted; the correction for the temperature of the magnets, which is found to be the most important of all, will have been determined. But the past had not been merely a season of preparation; it had afforded demonstrations of the ubiquity of those singular disturbances called *magnetic storms*, which could not otherwise have been obtained, and also data for the revision of the Gaussian theory. As to *magnetic surveys*;—in South Africa, Lieut. Clark, R. A. had joined the observatory at the Cape, as assistant to Capt. Wilmot; and it was proposed that the survey should comprehend, in addition to the colony, as extended a portion of the earth's surface, from the observatory, as circumstances would permit. The Admiralty had instructed the Admiral on the station to permit the sea portion of the survey to be carried into execution, so far as it was not prejudicial to the service, in her Majesty's vessels, and these surveys would include the coast on each side of the Cape, and then we should be better able to judge of the expediency of completing the survey by an expedition into the interior. In North America, Lieut. Lefroy, R. A. had been appointed to the principal observatory at Toronto, and was now in England preparing instruments. The Hudson's Bay Co. had liberally undertaken to furnish conveyances in the years 1843–4 and 1845, to extend the surveys to the Pacific Ocean; and they also offered passages on board their annual ships to England, and this would enable them to include in this magnetic survey Hudson's Bay and Straits. In the United States, Prof. Bache, (of Philadelphia,) during the last summer, had completed the survey of Pennsylvania, commenced in the previous year, in-

cluding three series of observations—the declination, inclination and intensity. Prof. Loomis* had extended his observations of inclination over great part of Ohio, Indiana, Illinois and Missouri. These, and numerous other observations and surveys in the States, would connect the northern British survey with the determinations of Capt. Barnett, of the *Thunder*, in the Gulf of Mexico. As to *observations at sea*, by Mr. Fox's instrument, the inclination and dip of the magnetic intensity might be measured with all the precision requisite for every use to which observations at sea could be turned, for the purpose of tracing out the isodynamic and other magnetic curves in portions of the globe covered by water. To extend and facilitate the use of this valuable instrument, the set of instructions drawn up by Col. Sabine, had been printed by order of the Admiralty, as a general circular, with some statements of the mode of using it practised on board the *Erebus* and *Terror*, and the hope was expressed that this method would be followed, not only in exploratory voyages, but by ships pursuing ordinary tracks, so as to furnish data for complete magnetic sea-charts. For these important observations, as well as the declination, it was necessary to eliminate the influence of the ship's iron,—an evil increasing from the greater quantity of iron now used. After mentioning the observations of Capt. Belcher, of the *Sulphur*, on more than twenty islands in the Pacific Seas, which had arrived in England, and would be published, and the important results deduced from M. Erman's journey in Siberia, the report noticed the subject of *magnetic disturbances*, respecting which Gauss remarked, that one of the results of this great British enterprise was that the existence and extension of these disturbances over the whole of the globe had been ascertained. As a physical fact, deeply connected with the general causes of terrestrial magnetism, this was indeed a result of the first magnitude, and considering all the circumstances, how it was modified by distance and locality, was eminently calculated to lead to theoretical truths. It distinguished what was local from what was general, and traced individual shocks from observatory to observatory, and station to station, till they were so far enfeebled as

* See Prof. Loomis's paper on the Magnetic Dip and Variation in the United States: this Jour. Vol. 43, p. 93–116. Also his paper on the Magnetic Intensity at several places in the United States: Trans. Am. Phil. Soc. Vol. 8, N. S. p. 61.

to be confounded and masked by the growing influence of other shocks nearer the principal point of observation. The report recommended smaller bars than those now in use, as more easily affected by sudden shocks. It was now considered advisable to collect from all sources to which we had access, accounts of the remarkable disturbances beginning with 1840 and 1841, arranging them in chronological order, and publishing them in volumes by themselves, and the first volume would be published in the course of this summer. The great disturbance of Sept. 25, 1841, which was observed at Greenwich, and was immediately made the subject of a circular from the Astronomer Royal to his brother observers, was also observed at Toronto, St. Helena, the Cape of Good Hope, and Trevandrum in Travancore. All these arrived in time to be inserted in the volume for 1841; and surely it must be regarded as a remarkable fact, that this casual phenomenon was seized upon by our observers in Europe, Asia, Africa and America, reported thence to England, reduced and printed, in three months and one week after its occurrence; "tantum series juncturaque pollet." The returns from the different stations showed that these disturbances were general; that, though the movements individually might not be, and in fact were not, always simultaneous, the observations on the same day never failed to exhibit unusual discordances at all the stations, and were generally characterized by the diminution more or less of the horizontal intensity, prevailing more or less for several hours every where, and the movement of the north end of the needle towards the west. Besides the colonial observatories, these phenomena were watched with great attention at the observatories of Prague, Munich and Greenwich. The report next noticed the new magnetic instruments and modes of observation. We can only enumerate the former, viz. the transportable magnetometer, Dr. Lloyd's induction inclinometer, Weber's inductive inclinometer, and another method proposed by Dr. Lamont. The report next enumerated the publication of various magnetic observations. The only expense incurred by the Association during the year was about £11 for observatory registers, and the committee prayed a continuance of their grant.

(*To be continued.*)

Art. XI.—*Meteoric Observations, made at New Haven, Conn. on the 8th, 9th, and 10th of August,* 1842; communicated by E. C. Herrick.

With the assistance of Messrs. Francis Bradley, R. T. Gill, E. Y. Gould, J. S. Hubbard, Porter Le Conte, and Wm. H. Way, I made arrangements for observations on shooting stars, throughout the entire nights of the 8th, 9th, and 10th of August, 1842. Very much to our disappointment, these arrangements were almost wholly frustrated by clouds; although in a few clear intervals we saw enough to satisfy ourselves that the meteoric sprinkling expected about that time, did not fail.

Our observations were made from the summit of the Hospital. Each night the corps of observers was on duty until 4 A. M. As usual, a quarter of the heavens was assigned to a single observer; and the meteor was reckoned in that quarter in which it commenced its course. Due care was taken that no meteor should be twice counted. The following are the notes of the observations.

Aug. 8. Observations commenced at 9h. 50m. P. M.: between this and 10h. the sky was tolerably clear, although hazy. Meteors seen, in

N. 3, E. 2, S. 1, W. 3, =9 in ten minutes.

From 10h. the sky was becoming more cloudy, and by 10h. 20m. was wholly overcast. Meteors seen,

N. 4, E. 2, S. 3, W. 5, =14 in twenty minutes.

The sky remained overcast until about 2h. 35m. A. M. (9th), when it was mostly clear. From this time to 3h. meteors seen,

N. 5, E. 14, S. 11, W. 8, =38 in twenty five minutes.

During this time the sky was estimated to be two-fifths clouded. At 3h. 15m. the sky was entirely overcast, and remained so with little alteration as late as 4h. Meteors seen,

N. 6, E. 6, S. 9, W. 8, =29 in fifteen minutes.

At 2h. 35m. through openings in the clouds, manifestations of what was presumed to be the Zodiacal Light, were discernible in the N. N. E., but nothing definite could be determined. Of the meteors seen by us this night, the radiant point could not be well settled, but we judged it to be somewhere near δ Persei.

Aug. 9. Observations commenced at 10h.; the sky hazy, and cloud about 5° high, around N. and W. Meteors seen,

from 10h. to 11h.	N. 11,	E. 17,	S. 12,	W. 14,	=54
11h. to 12h.	20,	27,	18,	14,	=79

At 11h. 45m. P. M. the sky began to be clouded, and by midnight, only here and there a star was dimly visible. From this time until at least 4h. A. M. the clouds prevented all observation.

Aug. 10. Observations commenced at 10h. 10m. Between this and 11h. meteors seen,

N. 28, E. 19, S. 21, W. 21, =89.

During these fifty minutes the sky was in general as much as one sixth part obscured by clouds, and for five minutes was wholly overcast. Most of these meteors were inferior in brilliancy to stars of the first magnitude; but one of them equaled Jupiter in splendor. The larger part radiated from the vicinity of the sword-handle of Perseus. At 11h. 5m. P. M. the sky became wholly overcast, and with scarcely any change continued so until daylight.

During the nights of the 11th and 12th, the sky was too cloudy for observation. The same was true of the nights from the 3d to the 7th, each inclusive. The nights of the 1st and 2d were clear. On the 1st, I watched alone for one hour ending 10h. 15m. P. M., principally in the N. and N. E., and saw *five* shooting stars, having little uniformity of direction.

From the observations above detailed, it is safe to conclude that the meteoric display which occurs about the 10th of August, was during the present year quite equal to its visitations since 1837. On comparison with former results, it may with confidence be inferred, that if the weather had been propitious, we should have seen more than a thousand shooting stars during the night of the 10th inst.

New Haven, Conn., August 16, 1842.

Art. XII.—*Bibliographical Notices.*

1. *Animal Chemistry, or Organic Chemistry in its Application to Physiology;* by Dr. Justus Liebig, M. D., Ph. D., F. R. S., M. R. I. A., Prof. of Chem. in the University of Giessen, &c. &c. Edited from the author's manuscript, by Wm. Gregory, M. D., R. K. S., &c., Prof. of Chem. and Med. in the University of King's College, Aberdeen. American edition, with additions, notes, and corrections, by Dr. Gregory, and others by Dr. J. W. Webster, of Harvard University. Cambridge, published by John Owen, 1842. 12mo. pp. 347. Also another edition, by Wiley & Putnam, New York. 12mo. 1842.

This work has come under our eyes too late to receive any but a passing notice; it is heralded by the enthusiastic applause of all who have perused it, and will be studied by all who watch the developments of organic chemistry under the hands of the illustrious doctor of Giessen. We here begin to enjoy some of the first fruits of that laborious research in organic chemistry which has occupied, especially, the German chemists, during several years past. The results of thousands of analyses of organic matters, seeming, as they often did when considered separately, of little practical value, and interesting chiefly to the working chemist, suddenly, as if by magic, assume, under the genius of arrangement and philosophic deduction, unexpected importance, and promise to stop short only of explaining the very principle of vitality itself. The complex results of vegetable and animal life, in the development from so few elements, of organs and tissues so variously constituted, has always been viewed as one of the most recondite questions of physical investigation. In the work before us, we are taught to view these operations no longer in the light of imagination, but to consider that the atoms of complex organisms are, like all other matter, subject to the control of *chemical laws under the influence of the vital principle*, and to believe that the carbonic acid, the result of respiration, is as truly the product of *combustion* as if it came from the burning of coals. One of the most remarkable developments of the book, is the identity in composition of matters usually considered as in no way related; thus, albumen and fibrine, whether animal or vegetable, whether from the serum of the blood, from wheat, or gluten, are identical in composition with each other; and what is still more remarkable, vegetable and animal caseine are not merely similar in composition, but absolutely identical, not with each other only, but with albumen and fibrine. Thus the following numbers express very nearly the composition of all these substances in one hundred parts. Carbon 54, hydrogen 7, nitrogen 15, oxygen, sulphur, &c. 23. This result is derived

mainly from the researches of Prof. Liebig and his numerous pupils in the laboratory of Giessen; although the labors of other chemists have also contributed to the result.

The views of Prof. Liebig, founded on the incontrovertible evidences of numerous analyses, cannot be gainsayed; and one of the most valuable features of the book is its suggestive character, showing us the importance of observations comparatively trivial when connected with the development of important truth. We cannot in our present limits give any notion of the mode in which a great variety of important topics, involving the whole province of animal and vegetable physiology, and the laws of vital energy, are discussed. Every one, whether scientific or not, who feels the least interest in the progress of knowledge, will read this book with pleasure and profit; while all who are engaged in similar pursuits must make it a constant study. It is a most lucid condensation of the results of years of laborious research, not of the author only, but of all his contemporaries.

This is the second part of the report on the progress and present condition of organic chemistry, drawn up by Prof. Liebig at the instance of the British Association; the first part, being the organic chemistry of agriculture, &c., and the third and concluding part, will be presented at the next meeting of the Association in August, 1843.

2. *Perkins's Algebra.*—The author of this work, already favorably made known by his "Higher Arithmetic," has brought to the task of preparing a manual of algebra the experience of both teacher and editor. He evinces a just conception of the utility of early training the learner in strict symbolic algebra, and holding his mind fast to the contemplation of letters or general signs, in preference to relaxing into numerical terms and coefficients. The three elemental branches of mathematics—arithmetic, algebra, and geometry, are separated by distinct outlines, and each should be studied by itself as a perfect system. The clearest ideas of geometrical demonstrations, are those which have no associations with algebraic statements of proportions or equations; and the most luminous and satisfactory processes in algebra, are those which are least encumbered with arithmetical numerals. Many a student toils through equations, working mainly by mere numerals, without obtaining any definite notion of the power and certainty of algebra, who, if taught to replace numerals by letters and always frame a formula for the answer, would at once find mysteries dissolved about him, and his labor changed into an exciting pastime.

Mr. Perkins has addressed himself to teaching algebra in its purity, and has skillfully carried his pupil through the successive stages of the science to equations of the higher degrees, and the methods of treating them generally, not omitting the theorem of Sturm

3. *Life and Writings of Ebenezer Porter Mason; interspersed with hints to parents and instructors on the training and education of a child of genius:* by DENISON OLMSTED, Professor of Natural Philosophy and Astronomy in Yale College. New York: Dayton & Newman, 199 Broadway. pp. 252.

A child of genius, young Mason truly was. We knew him well, and can fully unite with the respected author of this interesting biography, in the opinion that science has rarely lost two youthful cultivators of such eminent hope and promise, as Mason and Fisher.*

In all branches of science Mason excelled, but astronomy was his favorite department, and in this he made many new and original observations, such as would do honor to a veteran.† He was cut off at 21 years of age, when he had already given the fairest indications of future fame and usefulness.

It is impossible to peruse without deep emotion, the touching tale of his struggles with poverty, and with infirmities, induced or greatly augmented by his watchings with the stars—by his exposure to the chills of midnight—by his loss of sleep, and by the exertions he made to provide, through extra labors, for his expenses. Still, he went forward with courage and hope, and labored with cheerful alacrity, till death not only knocked at his door, but abruptly forced an entrance, and bore his victim away.

The beautiful taste in which his letters are written—the rich vein of poetry which ran through the solid mass of his philosophy—his child-like purity and simplicity, and his lovely social affections, commend him not less to our admiration and affection than to our esteem and respect; and we realize that when young Mason died, a rich gem dropped out from the coronet of science.

Professor Olmsted has well performed his almost parental labor, and this most interesting volume should be perused by the aged and the young—by the grave and the gay; for all may derive delight and instruction from the memoir of Mason. He fell—

> "Purpureus veluti cum flos, succisus aratro,
> Languescit moriens ;—lassove papavera collo
> Demissere caput, pluvia quum fortè gravantur."

4. *Davis' Manual of Magnetism; including also Electro-Magnetism, Magneto-Electricity, and Thermo-Electricity, with a description of the Electrotype Process:* for the use of students and literary institutions, with 100 original illustrations. Boston, No. 11 Cornhill; published by the author.

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* He was lost in the packet *Albion* on the Irish coast, in 1821.

† Vide his paper on Nebulæ, in the Transactions of the American Philosophical Society, Vol. 7, N. S., p. 165–213, with 4 plates.

The little works which are commonly published to promote the sale of apparatus, are rarely of much importance, beyond the primary objects of trade. This volume, however, of 220 pages, with the subsidiary catalogue of Mr. Davis's friend and ingenious collaborator, Mr. Joseph M. Wightman, which occupies 70 pages more, making with the appendages about 300 pages, is a very valuable present, not only to the experimenter, but to the philosopher. We are not aware that any work affords a view of the subjects which it illustrates, at once more condensed and complete, more luminous and exact. Some of the most profound theoretical deductions of this beautiful science are contained in this volume, and must greatly contribute, along with precise experimental directions, to the utility of the work. Here also the fine results of Dr. Charles G. Page (now of the Patent Office at Washington) are presented, both in theory and practice, and will be found by teachers in a more tangible form than in the elaborate memoirs and descriptions of the author, as published in different volumes of this Journal.

Having been much conversant with the instruments of Mr. Davis and Mr. Wightman, we can decidedly recommend them to colleges and academies, and to teachers generally, as being entirely worthy of their confidence, while they are much cheaper, not to say better, than similar instruments imported from abroad. The figures given by Mr. Davis and Mr. Wightman, in illustration of their instruments, are beautifully executed, either in wood engravings, or in electrotype copies, of which the frontispiece of Mr. Davis is an elegant example.

5. *Thoughts on a Pebble, or a First Lesson in Geology;* by the author of the Wonders of Geology. London, 1842. pp. 42.—This elegant little book, primer-like in size, and illustrated by fine colored plates and wood engravings, serves still to convey some of the grandest truths in geology. After what we know of its accomplished author, we might well expect, when he picks up and describes a pebble and gives us its history, that we should find

> —"books in the running brooks,
> Sermons in stones, and good in every thing."

In the features of a flint pebble—in the marine fossils which it contains, proving their previous distinct existence in the sea, and also its own soft or dissolved state—in the imbedding of the flint in the chalk, or rather its deposition in the cavities of the cretaceous rocks from the waters of that early ocean—in the elevation of those rocks from the deep—in the demolition of their sea cliffs by the waves, and in the subsequent wearing and grinding of the flinty fragments, until they became rounded in-

to pebbles and were finally cast again upon the shore—in all these and other facts Dr. Mantell finds topics of most interesting and delightful instruction. It is almost superfluous to add that the style is lucid, attractive, eloquent, poetical and philosophical; for all these attributes are combined in his writings. The elegant form of the little book, its snowy paper, excellent type and pictured engravings and cover, recommend it to the eye of taste; while to the philosopher as well as the pupil it presents truly a first lesson in geology, and cannot be perused without both pleasure and profit. It has passed through six editions, and we wish they may be repeated as long as stars glow or waters flow.

6. *On the Growth of Plants in closely glazed cases*; by N. B. Ward, F. L. S. London, 1842. pp. 95, 8vo.—The earliest published account of Mr. Ward's new method of cultivating plants without open exposure to the air, was contained in a letter to Sir Wm. Hooker, published in the *Companion to the Botanical Magazine* for May, 1836. The little volume before us presents a fuller account of this discovery, and of its important applications, indicated at the time, which subsequent experience has abundantly confirmed. Passing over the first and second chapters of this essay, which treat "Of the natural conditions of Plants," and "Of the causes which interfere with these conditions in large towns, &c." we extract from the chapter "On the imitation of the natural conditions of plants in closely glazed cases," an account of the manner in which Mr. Ward arrived at these unexpected results; which, singular as they at first seem, are only what an hour's reflection upon the physiology of vegetables might have anticipated.

"The science of botany, in consequence of the perusal of the works of the immortal Linnæus, had been my recreation from my youth up; and the earliest object of my ambition was to possess an old wall covered with ferns and mosses. To obtain this end, I built up some rock-work in the yard at the back of my house, and placed a perforated pipe at the top, from which water trickled on the plants beneath; these consisted of *Polypodium vulgare, Lomaria spicant, Lastræa dilatata, L. Filix-mas, Athyrium Filix-fœmina, Asplenium Trichomanes,* and a few other ferns, and several mosses procured from the woods in the neighborhood of London, together with primroses, wood sorrel, &c. &c. Being, however, surrounded by numerous manufactories and enveloped in their smoke, my plants soon began to decline, and ultimately perished, all my endeavors to keep them alive proving fruitless. When the attempt had been given up in despair, I was led to reflect a little more deeply upon the subject, in consequence of a simple incident which occurred in the summer of 1829. I had buried a chrysalis of a Sphinx in some moist mould contained in a wide-mouthed glass bottle, covered with a lid. In watching the bottle from day to day, I observed that the moisture which during the heat of the day arose from the mould, became condensed on the internal surface of the glass, and returned whence it came; thus keeping the mould always in the same degree of humidity. About a week prior to the final change of the insect, a seedling fern and a grass made their appearance on the surface of the mould.

"I could not but be struck with the circumstance of one of that very tribe of plants, which I had for years fruitlessly attempted to cultivate, coming up *sponte suâ* in such a situation; and asked myself seriously what were the conditions necessary for its growth? To this the answer was,—1stly, an atmosphere free from soot; (this I well knew from previous experience):—2dly, light:—3dly, heat:—4thly, moisture:—and lastly, change of air. It was quite evident that the plants could obtain light and heat as well in the bottle as out of it; and that the lid which retained the moisture likewise excluded the soot. The only remaining condition to be fulfilled was the change of air; and how was this to be effected? When I published my account in the "Companion to the Botanical Magazine," I overlooked the law respecting the diffusion of gaseous bodies, described in the preceding chapter, and stated that this change was produced by the variations of temperature, causing alternate expansions and contractions in the air surrounding the plants, and which of course produced a certain but very limited effect.

"Thus, then, all the conditions necessary for the growth of my little plant were apparently fulfilled, and it remained only to put it to the test of experiment. I placed the bottle outside the window of my study, a room facing the north, and to my great delight the plants continued to grow well. They turned out to be *Lastrœa Filix-mas* and *Poa annua*. They required no attention, the same circulation of the water continuing; and here they remained for nearly four years, the *Poa* once flowering, and the fern producing three or four fronds annually. At the end of this time they accidentally perished, during my absence from home, in consequence of the rusting of the lid, and the admission of rain water. Long before this occurred, however, I procured for the purposes of experiment some plants of *Hymenophyllum* and *Trichomanes;* and perhaps the most instructive way in which I can communicate the results of my enquiries will be to select a few out of numberless experiments, in the order in which they occurred."

We had marked for extract the descriptive list of the plants which were the subjects of Mr. Ward's experiments; but are obliged to omit it, as we have already exceeded the limits of this notice.

Residing in one of the darkest parts of London, and exposed to the "vapor of smoke" and soot which completely envelopes that metropolis, within whose limits not even a moss will fructify in the open air, (with the exception of *Funaria hygrometrica*, which is known to have an especial fondness for charcoal,) our excellent author has thus caused his favorite plants to flourish around him, for his own gratification, and to the admiration of those who have been privileged to witness his complete triumph over obstacles long deemed insurmountable. With equal advantage, but with greater facility, may Mr. Ward's plan be applied to parlor-culture in this country, where light is abundant, the atmosphere free from soot, and we have only to guard against cold, the excessive dryness of the air in winter, and the exhalations of sulphurous acid gas from coal fires, which when present in such minute proportions as to be wholly inappreciable to our senses, are yet highly injurious to plants cultivated in a dry air.

The most important practical application of these principles, that of the conveyance of living and growing plants upon long voyages, was

early suggested by Mr. Ward, and has been tested and confirmed by extensive experience; as appears from the instances related in the text, and the testimonials of Loddiges, Hooker, Lindley, Smith, Graham, &c. given in the appendix. As we have not sufficient space for the details of these experiments, we can only state the general results, which are, that plants from South America, Australia, India, &c. exposed during the voyage to temperatures varying from 20° to 120° Fahr. have almost uniformly reached England in a healthy condition, whenever the directions of the inventor have been faithfully attended to: viz. when the plants were not over-watered when packed up; the cases well closed; the glazed roof protected with strong wire-guard; or the panes accidentally broken immediately replaced; and the plants, thus protected from the spray of the sea, fully exposed to the light of day. The latter precaution is all-important; for, as Mr. Loddiges remarks, there cannot be a worse method of sending living plants than in these same cases placed in the dark.

Did our limits allow of further extracts from this little treatise, we would fain notice the hints which our author throws out for the illustration of vegetable physiology and pathology, on the importance of light in the animal economy, of pure air in the treatment of diseases and of the mode of obtaining it, and, above all, his kind attempts (worthy the true lover of Nature) to diffuse the enjoyments which his discovery affords him among the poorest classes of dark and crowded cities, "the most unfurnished with the means of life," many of whom, either from early associations, or from that love of Nature which exists to a greater or less degree in the bosom of us all, are passionately fond of flowers, and endeavor to gratify their taste at no small toil.

7. *Hooker's London Journal of Botany.*—Besides the continuation of Mr. J. Smith's paper on the arrangement and definition of the genera of Ferns, (which we have previously noticed,) the August number of this well-sustained periodical comprises a short article by E. Tuckerman, Jr. on the *Empetrum Conradii*, *Torr.*, which, having been established by Dr. Klotzsch, of Berlin, as a separate genus under the pre-occupied name of *Tuckermannia*, Mr. Tuckerman has with peculiar propriety given it the name of *Oakesia;* thus paying a deserved compliment to Mr. Oakes of Ipswich, Mass., one of the discoverers of this interesting plant within the limits of that state, and "whose name is inseparably connected with the New England flora." Dr. Torrey was led to suggest the probability of the existence of this plant in Newfoundland from the enumeration of a second species of *Empetrum* by Pylaie, in his catalogue of the plants collected in that island; and the fact has recently been confirmed by Mr. Tuckerman, who examined a

Newfoundland specimen in the herbarium of the late Mr. Lambert. We may be allowed to correct an inadvertent mistake in the above mentioned paper of Dr. Torrey (*Ann. Lyc. New York*, 4, *p.* 87) respecting M. Pylaie, who, although "he never lived," it is true, "to complete his Flora of that large island," is, if we mistake not, still in the land of the living.

8. *Hooker's Icones Plantarum.*—In announcing in the bibliographical notices of the preceding number of this Journal, that this useful work would be regularly continued by the present publisher, (H. Baillière, London,) we should have added that it will appear quarterly. The 9th number of the entire work, or Vol. I, part 1, of the new series, has already reached us.

9. *A Report on the Insects of Massachusetts, injurious to Vegetation.* By THADDEUS WILLIAM HARRIS, M. D. *Published agreeably to an order of the Legislature,* (*of Massachusetts,*) *by the Commissioners on the Zoological and Botanical Survey of the State.* Cambridge, 1841. pp. 459.

We have examined this work with care, and with uncommon interest and pleasure. Its object, which is perhaps sufficiently evident from the title, is principally to furnish the agriculturist with full information concerning the insects which ravage his crops and destroy his trees; and as far as practicable to give him the means of successful defense. To Dr. Harris we naturally look as the man best qualified to do justice to a task, demanding no little previous preparation, and much personal inquiry, as well as an extensive knowledge of the labors of others in this field. The work, it must be remembered, is intended for the use of *the people*, and it was therefore necessary to give it a readable and popular shape; and this object is secured by our author without sacrificing scientific arrangement and precision.

The Report opens with a brief yet comprehensive introduction, containing a general view of the metamorphoses of insects, their anatomy, and the characters of the orders into which they are divided. The remainder of the book is devoted to the detailed descriptions of the various noxious insects, arranged in a systematic manner; accompanied with directions as to the best mode of destroying these enemies, or of preventing their attacks. The scientific name of the insect is given in every instance, as was obviously necessary. The following remarks of Dr. Harris in regard to the use of scientific terms in natural history, are so appropriate and judicious, that we cannot forbear quoting them.

"Objections have often been raised against the study of natural history, and many persons have been discouraged from attempting it, on account of the formi-

dable array of scientific names and terms which it presents to the beginner; and some men of mean and contracted minds have made themselves merry at the expense of naturalists, and have sought to bring the writings of the latter into contempt, because of the scientific language and names they were obliged to employ. Entomology, or the science that treats of insects, abounds in such names more than any other branch of natural history; for the different kinds of insects very far outnumber the species in every class of the animal, vegetable, and mineral kingdoms. It is owing to this excessive number of species, and to the small size, and unobtrusive character of many insects, that comparatively very few have received any common names, either in our own or in other modern tongues; and hence most of those that have been described in works of natural history, are known only by the scientific names. The latter have the advantage over other names in being intelligible to all well-educated persons in all parts of the world; while the common names of animals and plants in our own and other modern languages are very limited in their application, and moreover are often misapplied. For example, the name *weevil* is given, in this country, to at least six different kinds of insects, two of which are moths, two are flies, and two are beetles. Moreover, since nearly four thousand species of weevils have actually been scientifically named and described; when mention is made of '*the weevil*,' it may well be a subject of doubt to which of these four thousand species the speaker or writer intends to refer; whereas if the scientific name of the species in question were made known, this doubt would at once be removed. To give to each of these weevils a short, appropriate, significant, and purely English name, would be very difficult, if not impossible; and there would be great danger of overburdening the memory with such a number of names; but by means of the ingenious and simple method of nomenclature invented by Linnæus, these weevils are all arranged under three hundred and fifty five generical or sir-names, requiring in addition only a small number of different words like christian names, to indicate the various species or kinds."

To give an analysis of the work is scarcely practicable. From the nature of the case it cannot be expected to be perfect, for the study of this branch of science has been little prosecuted in this country; and the united and long-continued labors of many persons are needed to explore so wide a range. But we confidently recommend Dr. Harris's work as a most comprehensive synopsis of what has hitherto been done in this department by others, enriched with large contributions resulting from his personal labors. The style of the treatise is characterized by simplicity and good sense.

To the mere scientific entomologist, the book will be very acceptable on account of the many new species which it describes, and the many valuable facts and suggestions with which it is interspersed. We hope it will give an impulse to the study of insects among us, and induce many more to assist in reaping the large harvest which lies before American entomologists.

We wish that the author had given figures of the insects which he has described; for as every one knows, an animal is recognized, especially by the unscientific, much more readily by a drawing than by a description. But from a hint in the prefatory letter, we are led to

believe that the compensation allowed the author was too small to permit him to incur this expense. This should not have been so. The commonwealth of Massachusetts, deservedly renowned both here and in foreign countries, for her patronage of science, may justly feel an honest pride in counting among her sons, a man adequate to such a task, and she should have granted him the most ample means of illustrating this important work. C.

10. *The Botanical Text Book, for Colleges, Schools, and private Students;* comprising, Part I. An Introduction to Structural and Physiological Botany; Part II. The Principles of Systematic Botany, with an account of the chief Natural Families of the Vegetable Kingdom, and notices of the principal officinal or otherwise useful Plants. Illustrated with numerous Engravings on wood. By Asa Gray, M. D., Fisher Professor of Natural History in Harvard University, &c.

The Text Book of Dr. Gray, affords at once the most compendious and satisfactory view of the vegetable kingdom which has yet been offered, in an elementary treatise, to the American public. In a style remarkable for its correctness and perspicuity, the author has traced and unfolded the vegetable structure, from its simplest forms up to its most complicated and elaborate developments. He has presented us with the first principles of the science, in accordance with the beautiful and truly philosophical doctrines of Wolfe and Goethe—explaining the laws, and illustrating the processes by which the external organs of plants are gradually modified, or metamorphosed, from the crude cotyledons of the germinating seed, to the most delicate component parts of the flower and the fruit. We are thus enabled to comprehend, in the most satisfactory manner, all those curious combinations and suppressions of organs, those fantastic deviations from symmetry, or normal arrangements of parts, which have hitherto been considered so mysterious, and have so long baffled the sagacity of naturalists. The admirable doctrine of vegetable *metamorphosis* has, indeed, given to the science of botany an entirely new aspect. As our author in his felicitous manner observes, "the application of this theory, like the touch of the spear of Ithuriel, causes the most anomalous structures and disguised forms of vegetable organization, to reveal their typical state and primitive character."

With this Text Book in their hands, the teachers of botany in our seminaries may speedily elevate the study to its legitimate rank among the natural sciences. Fascinating as it has ever been to gentle minds, by reason of the beauties of its objects, it may now be invested with an interest hitherto unknown to its votaries. While the student will be attracted by those charms so obvious to the senses, his faculties of ob-

servation and comparison may find the most interesting employment, and all his reasoning powers be exercised according to the strictest rules of logic and philosophy. The investigation of the true characters of plants will conduct him at once to a just estimate of their properties, and enable him to judge correctly of their economical value; so that while he is indulging in the pleasures of science for their own sake, he may at the same time silence the cavillings of the mere utilitarian, by demonstrating the *practical* importance of true scientific attainments. This is one of the eminent advantages resulting from an intimate knowledge of vegetable structure and physiology, and from the study of those natural affinities which suggest the grouping of plants into families or orders; and such are the advantages which may be confidently expected from the general introduction and proper use of the Botanical Text Book, in the many respectable seminaries of learning in the United States.

The principles on which the vegetable kingdom is classified, or arranged into natural families, are briefly but lucidly exhibited, in the second part of the work; and cannot fail to be perfectly intelligible to every inquiring mind. When the botanical student shall have become familiar with the elementary truths so ably set forth in this Text Book, he will have only to provide himself with a copy of the *Flora of North America*, (now in process of publication by the same author, in conjunction with his accomplished friend, Prof. Torrey,) and diligently to consult the pages of that inestimable work, in order to know and appreciate the vegetable treasures distributed over the vast territory, extending from the Gulf of Mexico to the Arctic seas. With such aids, and such attractive inducements to a rational acquaintance with the vegetable creation, it may be fairly calculated that the study of botany in our country will soon be adapted to the actual condition of the science; and that its votaries will not only multiply in number, but be enabled to vindicate its claims to the rank of a truly useful and philosophical pursuit.

The writer of these hasty and desultory remarks, is unwilling to conclude without manifesting his sincere gratification at the recent appointment of the author of the Botanical Text Book to the Fisher Professorship of Natural History in Harvard University. It is a distinction as richly merited as it was honorably conferred; and while we may hope that the situation will afford the incumbent many facilities to prosecute his botanical labors with increased advantage, it will not be denied that the Trustees of Harvard have been both sagacious and fortunate in securing, for their venerable institution, the services of the new Professor of Natural History. W. D.

11. *Monographie d'Echinodermes vivans et fossiles, par* L. Agassiz. 3d and 4th livraisons, contenant les Galerites, et les Dysaster, par E. Desor, et l'Anatomie du genre Echinus, par G. Valentin. 17 plates. Neuchatel, 1842. Livraison 4 has a folio atlas of 9 plates, illustrating the anatomy of the genus Echinus.—This valuable work is now continued by the addition of the two parts above mentioned, and we refer for the general plan and contents of these former parts and the design of the work, to our former notices in Vol. xxxvii, p. 369, and Vol. xlii, p. 378.

The part here devoted to the anatomy of the genus Echinus, is written by the friend of Prof. Agassiz, Professor Valentin, and will be found an important addition to our knowledge of this order of animals. The accompanying plates are done in a masterly style, and almost supersede the necessity of detailed anatomical description.

We are not informed whether M. Valentin is to go through the other genera of Echinodermes in the same style, but infer that such is the fact.

We received also by the same parcel, the 14th livraison of the Fossil Fishes, both text and plates.

12. *Della Elettrotipia Memorie di* Francesco Zantedeschi *con cinque tavoli elettrotipiche di* Zantedeschi e Antonelli. Venezia, 1841. 4to. pp. 52.—This is the title of an elaborate memoir on the electrotype, by Prof. Zantedeschi of Venice, which we have received recently from the author, through the kindness of Prof. J. W. Draper of New York. The illustrations of Prof. Zantedeschi are taken from subjects of highest art, and some of them are done in sharper clearness than any electrotypes we have seen, particularly as most of them are merely outlines, requiring the utmost delicacy of finish to produce the effect designed by the artist.*

Prof. Z. discusses the science connected with the art in a very satisfactory way, but he seems to have confined his attention chiefly to the deposits of copper, and not to have extended his researches to other metals under the same circumstances. We have reason to believe that one of the most useful applications of this art to the wants of society, is in the manipulation of the precious metals; and we are recently informed by a manufacturing house, that they have succeeded perfectly in the substitution of electric gilding for the old process by mercury, and that the results are more satisfactory in every way, both in the uniformity in thickness of the deposit and in the health of the workmen, as well as in economy.

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* We must except from this remark, the illustrated copy of Thomson's Seasons, edited by Mr. Corney, (Longman & Co., 1842,) in which all the illustrations are from perfect electrotype copies of the most exquisite wood engravings.

13. *London Microscopical Society.—Reports of the first and second anniversaries of the Microscopical Society of London, held on the 15th of February, 1841 and 1842, at the Society's rooms, No. 21, Regent St.*

This society was founded on the 15th of February, 1840, and has held the two anniversary meetings, the reports of which are now before us. The increase of microscopic observers, and the opening of so many new fields of observation, attendant principally on the labors of Ehrenberg and Owen, rendered the establishment of such a society a legitimate and desirable object, and it has not been found to clash with any previously organized scientific body for other objects.

On the contrary, numerous papers have been read before it and will appear in its Transactions, which would probably not have seen the light except for the connection of the authors with this society. A cabinet of microscopic objects has been begun, which already contains nearly seven hundred specimens; and it is intended that the Society shall also become the possessors of a full set of all the most esteemed forms of microscopes, made expressly for them as samples of the best performance of the most celebrated makers both in London and on the continent. The formation of a library of microscopical works is also a primary object of the Society, and this part of the plan has been begun by the purchase of Ehrenberg's "Infusions-Thierchen," and numerous other valuable publications. The proceedings of the ordinary meetings are published regularly in the Microscopic Journal, conducted by Mr. Cooper, which is the authorized organ of the Society. The number of members at the time of the second annual meeting, was one hundred and eighty five; the number of papers read the last year, fifteen; the publication of some of the earlier papers is in progress, and a part of the Transactions will soon be ready for distribution.

14. *A Monograph of the Limniades, or fresh-water univalve shells of North America.* By S. Stehman Haldeman, Member of the Academy of Natural Sciences, Philadelphia, &c. No. 5. Phila. July, 1842.

We have previously noticed Mr. Haldeman's undertaking in a favorable manner. The fifth number of his Limniades has been received here, and contains figures and descriptions of fourteen species of Limnea, viz. *carperata*, *solida*, *columella*, *macrostoma*, *humilis*, *Bulimoides*, *pallida*, *vitrea*, *obrussa*, *ferruginea*, *gracilis*, *glabana*, *decollata*, *palustris*.

The illustrations of this work are on copper, by Alex. Lawson, drawn and colored by Miss Lawson, and are so perfect as certainly to leave nothing to be desired.

15. *New Scientific Journals.*

1. *The Microscopic Journal, edited by Daniel Cooper, Esq.* London: J. Van Voorst.—This Journal came into existence about the same time as the Microscopical Society, and it is, as has been stated in our notice of that society, its authorized organ of communicating the proceedings and abstracts of its papers to the scientific world. It also contains many original and valuable articles from other sources. It is published monthly, and nineteen numbers have already appeared.

2. *The Geologist.* By CHARLES MOXON, Esq. H. Baillière, publisher, 219 Regent St. London. (Monthly.)—We have not seen this journal; but suppose it to be, as its name implies, wholly devoted to geology. It was commenced on the 1st of January, 1842.

3. *The Chemist, or Reporter of chemical discoveries, &c.* By CHAS. WATT and J. WATT, Jr. London: R. Hastings, 13 Cacey St.—This journal is also monthly, and has been in existence about two years; the second volume is completed. Not having examined the work, we cannot speak of its value.

4. Under the same head, we may properly notice a change which has recently been effected in the editorship of our esteemed contemporary and fellow laborer in the general cause, The Journal of the Franklin Institute; whereby the American Repertory of Arts, formerly conducted by Prof. Mapes, in New York, has been transferred, with its editor and subscription list, to the Institute Journal, thus combining the talent of the two works. This change must be attended with valuable results to the energy of the old work, and raise its already high reputation. The two hundred and first number of this work is now published.

5. *The Cambridge Miscellany* of Mathematics, Physics, and Astronomy. Quarterly. Edited by B. PEIRCE, A. M., Prof. of Math. and Nat. Phil. in Harvard University. Boston. Nos. 1 and 2.—This journal is devoted principally to the solution of mathematical questions, proposed either by the editor or his correspondents. It has, however, a chapter devoted to general physical science, in which interesting papers have been published by Prof. Lovering, the Editor, and other contributors. Each number contains forty eight pages,—it was commenced in April of the present year.

6. *Memoirs and Proceedings of the Chemical Society.* Parts 1 and 2. London.—This is the organ of the London Chemical Society, and is published at irregular intervals, as the papers of the Society require.

The labors of this society have been already of so important a character, that chemists will, without our advice, keep track of its doings.

MISCELLANIES.

DOMESTIC AND FOREIGN.

1. *On the use of Carbon in Grove's Battery.*—Some months since, being engaged in experiments with Grove's flat-celled battery, some of the prominent defects of form, construction and expense seemed to me to be remediable, by another mode of construction, and the use of a cheaper negative element. About the same time, I learned that Berzelius had, in a letter to Dr. Hare, given an account of a battery where coke was at once the negative element and the containing vessel for the nitric acid.

I have since made many experiments, and now give the result which seems most promising. Natural plumbago, or the mixture of it with sand, such as is used in the manufacture of crucibles, gives the form of carbon which is at once the most effective, cheap and manageable. A battery was constructed of six cylindrical members of native plumbago, each element one inch in diameter and two inches high, placed in nitric acid of the commercial strength, contained in a cylindrical cup of porous queen's ware, and opposed by a circular zinc element amalgamated. The connection was formed by a wire dipping from each zinc into a mercury cup excavated in the top of the plumbago cylinders. This battery of six members gave results which were highly satisfactory. In decomposing power, it accomplishes more than 100 pairs of zinc and copper of 6 inches square each. It gave 5 cubic inches of the mixed gases of water in less than 50 seconds, or 1 cubic inch in 12 seconds. It also maintained for nearly an hour, at full incandescence, 14 inches of No. 30 platina wire, coiled into a spiral. In all other modes of exhibition it shows a proportionate power.

I am now constructing a battery of large series on this plan, and when the results are obtained will publish them more at length. I would remark to those who may be interested in constructing similar batteries, that plumbago is easily obtained from Sturbridge, Mass., of a compactness very suitable for batteries; and moreover, that (as before remarked) the mixed plumbago* of the manufacturers of "black lead" ware, answers very well. The porous cells used in my experiments have been made at Jersey City, N. J. B. Silliman, Jr.

Yale College Laboratory, Sept. 12, 1842.

2. *Ehrenberg's Notices of American Infusoria.*—On the 25th of March, 1841, M. Ehrenberg made a communication to the Royal Academy at Berlin, in which he referred to specimens of American fossil

* To be obtained of J. W. Ingall, Taunton, Mass.

infusoria, sent for his examination by Professors Silliman, Bailey and Hitchcock. The chief results of his examinations of American species are—

1. In North and South America, there occur not only living but fossil microscopic organisms, forming strata geologically important, and very similar in their relations to the European.

2. The American forms are for the most part similar to the European.

3. One hundred and forty-three species are common to Europe, and seventy-one, or one third, peculiar to America.

4. Not one of the American infusorial deposits resembles in its elementary forms the chalk marl of the south of Europe. Nevertheless there is found in the deposit near Spencer, Mass. the *Rotalia globulosa*, which is decidedly peculiar to the writing chalk.

(This statement of Ehrenberg was made before he was aware of the discovery made by Prof. W. B. Rogers of the tertiary infusorial strata in Virginia. I have shown these strata to agree with those of Oran, &c. in containing immense numbers of the same species of Actinocyclus, Coscinodiscus, Dictyocha, &c. which characterize the chalk marls of Oran, Caltasinetta, &c. Some of these species I have seen still living in our waters, not only on the sea-shore, as at Boston harbor, but also sixty miles up the Hudson river.

The occurrence of the marine *Rotalia globulosa* in the infusorial deposit of Spencer, an inland town of Massachusetts, would lead to curious inferences were the fact well established; but having repeatedly examined specimens from that locality, and never having seen in them any but fluviatile organisms, I am inclined to think that a portion of chalk may have been accidentally mixed with Ehrenberg's specimens.—J. W. B.)

5. Most of the fossil deposits in North America are found in peat bogs, and contain forms of infusoria clearly referable to the brackish fresh-water forms of the sea coast, although some of them are at a great distance from the sea.

(I found some of the most common fossil species, still living, as far west as Ouisconsin river.—J. W. B.)

6. Catalogue of American infusoria determined by Ehrenberg:

A. Fossil.

Amphiphora navicularis
Cocconema Arcus
" lunula
Eunotia amphioxus
" biceps
" bidens
Eunotia Monodon
" prærupta
" uncinata
" zebrina
Fragillaria constructa
" pinnata
" paradoxa

Gomphonema Americana
" lanceolatum
" nasutum
" undulatum
Himantidum gracile
Navicula Americana
" amphigomphus
" amphioxys
" Bacterium
" Baileyii
" costata
" decora
" dilatata
" gastrum
" grammatostoma
" Hitchcockii
" legumen
" oblonga
" porrecta
" pumilis
" silicata
" Sillimanorum
" tumidula
Staurosira construens
" pinnata
Tabellaria amphilepta
" nodosa
" biceps
Spongia ramosa
" serpentina
Spongia setosa
Thylacium ossiculum
" semiorbiculare

B. Recent.

Achnanthes pactrypus
Actinocyclus hexapterus
Cocconeis oceanica
Dictyocha panduriformis
" splendens
Echinella moniligera
Fragillaria catena
" pinnata
Gomphonema subtile
Grammatophora Mexicana
Navicula Campylodiscus
" bicarinata
" crucigera
" læta
" reticulata
Podosira moniliformis
Spongia capitata
" clara
" Neptuni
" obtusa
" uncinata
Globulus porosus
Spirulina vivipar
Biloculina tenella
Textilaria plicata

To this list can be added a great number both of recent and fossil species. J. W. B.

3. *Acarus Crossi; Experiments of W. H. Weekes, Esq.*—We have been favored by the kindness of W. G. Lettsom, Esq., of the British legation at Washington, with an early copy of a paper read by Mr. Weeks, March 15th, 1842, before the London Electrical Society, on the Acarus Crossi. It is now about four years since the scientific world was excited in an unusual degree by the Voltaic experiments of Mr. Andrew Crosse, in which Acari appeared on and about the apparatus and subject of experiment, during a long continued electrical action. The general belief seems to have been, that in spite of all precautions,

the ova of these insects must have been about the apparatus. We published at the time Mr. Crosse's experiments, and our views of the nature of the results.

Mr. Weekes' paper is a detailed account of the means employed to insure perfect freedom from the presence of all organic life, in and about the apparatus employed, and these means certainly seem to have been as perfect as can be devised to effect this object. The solution operated on was silicate of potassa, enclosed in an air-tight vessel of glass, to which the electrical current passed. The operation of the battery was continued during more than thirteen months. Two apparatus precisely similar in all respects were employed, only that one contained pure oxygen gas obtained from oxide of manganese at a red heat, and the other common air. The experiment was begun December 3d, 1840, and says Mr. Weekes—

"About the 16th of November, 1841, I observed that the silicate in the tumbler had become much more transparent in its general appearance; and, to me, it seemed as though the greater portion of silicious matter previously held in solution, had now been attracted to the negative pole. At this time I resolved to examine the apparatus daily; and, on the afternoon of the 25th November, while engaged in using a microscope to the groups of spots or splashes as I have hitherto denominated them, and which I now found to consist in an infinitude of extremely minute pyramidal crystallizations of flinty quartz, I discovered five perfect insects, the exact representatives of those which originally appeared in the Broomfield experiments, crawling freely about on the inner surface of the bell glass: two were full grown, the rest in a less forward state."

We should be glad to republish Mr. Weekes' entire paper, but our limits forbid. It is sufficient to say, that his experience proves in a satisfactory manner the accuracy of Mr. Crosse's accounts, and that the anomalous insects appeared from time to time and in considerable numbers. We have, through the kindness of Mr. Lettsom, been favored with a view of these remarkable creatures, and we find them to correspond in form with the figures of Mr. Crosse, given by us as above quoted. Truly, there are more things in heaven and earth than are dreamt of in our philosophy.

4. *Remarks upon Mr. Murchison's Anniversary Address before the London Geological Society;*—extract of a letter from Prof. E. Hitchcock, of Amherst College, to the Editors, dated July 5th, 1842.—My pleasure in reading Mr. Murchison's able Address at the anniversary of the London Geological Society, in February last, has been greatly diminished by finding, in the first place, that he supposes I have misunderstood his opinions respecting the glacier theory: in the second place, by the certainty that he misunderstands mine.

I freely acknowledge that my views respecting the glacier theory, given in my Anniversary Address in Philadelphia, are so expressed as

to be liable to be misunderstood. The interesting work of Agassiz, *sur les Glaciers*, showed me how the passage of large masses of ice over the surface could produce effects, precisely like those which for twenty five years I had been examining with deep interest all over New England. No other facts which I had ever seen stated, would show how our striæ, our transported bowlders, and accumulations of drift, could be explained; the flood of light which was thus unexpectedly thrown into my path, delighted me; I expressed a warm admiration of the views of Agassiz, and used some terms with perhaps too extended a meaning. For example, I supposed that the term *moraine* might designate any accumulation of detritus produced by advancing ice, whether glaciers or icebergs. Neither when I wrote my Address, nor subsequently, have I supposed that the moraines of this country were produced by glaciers, but always by icebergs; as I endeavored to show, in an extended paper on drift, which I read in your presence, before the meeting of the Association of American Geologists and Naturalists in Boston last April. And whatever impression my language may have conveyed, I now declare, that I have never supposed it possible to apply the glacier theory of Agassiz to this country without modification. The difficulties which I stated in my Address, have always appeared to me insuperable against its adoption.

But it may be said, that I stated in that address, that I felt "constrained to believe its fundamental principles to be founded in truth." Yet in the next sentence I added, "modifications it may require;" and in a note I declared myself satisfied that "it will need important modifications;" and then, in order to show distinctly what I meant by its "fundamental principles," and to give the final conclusion at which my mind had arrived, I stated my conviction, that "*glacio-aqueous* action (by which I mean (see note, p. 29; also this Jour. Vol. 41, p. 258) the joint action of ice and water, without deciding which has exerted the greatest influence) has been the controlling power in producing the phenomena of drift." Whether the vast currents of water, which must have been concerned, were the result of the sudden melting of the thick belts of ice around the poles, as Agassiz supposes, or of the elevation of the regions around the poles, whereby the ocean was thrown over the land, agreeably to the views of De la Beche; or by the elevation of different parts of continents from the ocean, while the greater part of those continents were beneath the waters, according to Lyell and Murchison, I do not feel competent to decide. I rest at present in the position, that ice and water were both concerned; and am in doubt whether geologists will ever be able to go much farther and remain upon the *terra firma* of logical induction. But to have reached this principle, in which I fancy nearly all geologists now agree, seems to me an immense advance on this subject; and for this progress in my own mind, I feel

greatly indebted to Agassiz. I now feel as if the dynamics of this most difficult subject were nearly settled. Mr. Lyell had, indeed, done very much towards such a result; but the striæ and moraines still remained unexplained, till the glaciers of the Alps had been explored.

As to Mr. Murchison's views, I did indeed state, on the authority of a friend in London, who is a member of the Geological Society, that Mr. Murchison among others had "more or less fully" adopted the views of Agassiz. But I meant only that general adoption which I had given them; for in a note on page 28,* I stated Mr. Murchison's views in his own words, from his pamphlet on the *Geological Structure of Northern and Central Russia, &c.*, giving the precise theory which he has more fully explained in his recent address: so that in fact, there has been no misapprehension of his opinions in my own *mind*, whatever error there may be in my *language*. In explaining his views I added this remark: "very likely the glacier theory may need some analogous modification to adapt it to this country." It will be seen from this sentence, that my mind was entirely unsettled as to the *origin* of the ice and water which have produced drift, and that I was quite as favorably inclined towards the peculiar views of Mr. Murchison as of any other geologist.

It is of little consequence to the public what are my views on this subject; and I should not have asked a page of your Journal for explanation, did I not fear that my views, thus misunderstood, might be regarded as an index of the opinions of American geologists, as indeed Mr. Murchison intimates, (p. 68.) But I doubt whether he could find any one of them ready to adopt the unmodified glacier theory of Agassiz; although doubtless many will admire the ingenuity and indomitable perseverance of that distinguished naturalist, and thank him for the great light which his labors have cast upon the phenomena of drift.

5. *Ancient Meteorological Notices.*—The following statements are copied from "*An Appendix touching Prodigies in New England,*" subjoined to "A Sermon, (entitled *the Way to Prosperity,*) preached to the Honourable Convention of the Governour, Council, and Representatives of the Massachuset-Colony in New England, on May 23, 1689. By *Cotton Mather.* Boston: Printed by *Richard Pierce*, for *Benjamin Harris.* A. D. 1690."—16mo., in all pp. 53. The accounts have received a tinge from the fancy of the learned and curious writer, but are evidently entitled to ordinary credit. The fragments, which were probably thrown down by the explosions of the meteor, may have fallen in some uninhabited region, and there have buried themselves beyond the reach of investigation. E. C. H.

* This Jour. Vol. XLI, p. 257.

1. *Red Snow near Boston in* 1688. "Moreover it is credibly affirmed that in the Winter of the Year 1688, there fell a *Red Snow*, which lay like Blood on a spot of Ground, not many miles from *Boston;* but the Dissolution of it by a Thaw, which within a few hours melted it, made it not capable of lying under the contemplation of so many *Witnesses* as it might have been worthy of. The *Bloody Shower* that went before the suffering of the ancient *Britains* from the Picts, (a sort of People that painted themselves like our *Indians*,) this Prodigy seemed a second Edition of."

2. *Explosion of a meteor near Boston, Oct.* 1, *O. S.* 1689. "And in the opinion of the most Critical Observers, throughout the Countrey, they were *prodigious*, or at least *Uncommon Sights and Sounds*, which on the first of *October* in the Year 1689, We were entertained withal, and not unlike those which *Pliny* mentions as *presages* to the *Cimbric* Wars of old. For on that Day, in the Morning, while the *Sky* was too clear, to give us a suspicion of any thing like Thunder approaching, there suddenly Blazed a *Flame*, in the fashion of a *Sword;* which Blaze after a continuance, far longer than that of an ordinary *Lightning*, expired in a smoke that gave Terror unto the Beholders of it. But hereunto succeeded immediately very terrible and Repeated Noises, exactly like *Volleys* of *small Shot*, not without *Reports* like those of *Great Guns* superadded thereunto. This was a *Scœne* which all the Colonies of this large Countrey and Thousands of People, at once were Spectators of, carrying in it, *something*, beyond the *known Laws* which ordinary *Meteors* are Conform'd unto. And herein was indeed One Circumstance, that gave Demonstration of something *Rare* and *Great* in this Occurrent; That persons which were Distant from one another many scores of Miles above an Hundred, yet at the same Time, both *Saw* and *Heard* the whole of what is now related; and though I know, the Fancies of men applying themselves unto what is in the Clouds, are Fruitful even to a Ridicule; strong *imagination* being able to find, even a *Juno* in them, and all that can be *any where* imagined; the *Shapes* of *Clouds*, like the *Clinks* of *Bells*, humoring the *Thoughts* of *any one;* yet in *This* Accident, no small numbers of Gentlemen, who do not use to be *imposed* upon, but count no Trial severe enough to examine Things of this Nature with, were so surprised as with one mouth to say, *The Finger of God was here!* But with *Him* are left the Events of all. And in the mean time we are not ignorant, that

'Nunquam Futilibus Excanduit Ignibus Æther.'"

6. *Meteor of November* 10*th*, 1841.—This meteor was observed in Boston and vicinity, by Mr. W. C. Bond and by his son; and also at New Haven, Conn., about 8 P. M., Nov. 10th, 1841. At *Boston*, the

meteor traversed an arc of about 50° toward the S. W. point of the horizon, passing several degrees westward of Fomalhaut, and disappearing in the distance at an altitude of about 10°. The preceding part of the body of the meteor appeared intensely white, and the following part of a deep blue; a brush of light 2° or 3° long, was left near and a litttle above δ *Aquarii*, and remained visible more than ninety seconds. At *New Haven*, the meteor was first seen about half a degree below the Pleiades, and disappeared midway between β and θ *Ceti*, leaving a trail 8° or 10° long, near the Whale's head. This trail remained visible full three minutes. The meteor was two or three seconds in passing, and some thought it had a well-defined disk 3′ or 4′ in diameter.

These observations are too vague to justify much labor in calculations founded upon them, but a simple geometrical construction of the case gives the following results.

The meteor was twenty five to thirty five rods in diameter, and was first noticed by Mr. Bond. It was then over Plymouth, forty one miles S. 31° E. of Boston, at an altitude of sixty five miles and a quarter. It moved S. 27° W. 31 miles, and was seen at New Haven, when over Buzzard's Bay, twenty four miles W. of Holmes's Hole, and after holding the same course fifty miles further it began to leave a trail of light, off Montauk Point. This trail was sixteen or eighteen miles long, and was something really left at that place only, since the meteor was then twenty or thirty miles farther from Mr. Bond than at the beginning of its course, and the trail being seen at that part of the track could not have been caused by its proximity. Finally, after a run of one hundred and fifty three miles, it disappeared over the ocean in lat. 40° 7′ N. and long. 71° 16′ W., at the same altitude as when first observed. The same point of disappearance was noticed both by Mr. Bond and at New Haven, proving that the meteor suddenly became invisible, and was not merely lost in the distance. The velocity of this body was very great. According to the New Haven estimate of the time of its flight, its apparent velocity was not less than fifty miles per second. The tangent of this part of the ecliptic being inclined to the track of the meteor at an angle of about 19°, would make a deduction of about sixteen miles for the earth's motion,—more than a hundred times swifter than a cannon-ball. Twelve minutes at that rate would carry it round the earth, and five weeks would carry it far beyond the sun.

It must however be remembered, that these results are obtained, not by calculation, but by construction; and that the distances may vary perhaps one or two miles from the truth, but not more than that; for the lines of disappearance when constructed, intersect each other, proving the accuracy of Mr. Bond's and of the New Haven observations;

and if the observations are accurate, the errors of construction cannot possibly amount to a mile on any one line.

It may be remarked that the velocity of this meteor is so great, that were it a body revolving about the sun, its orbit must be hyperbolic.—T. H. *in the Boston Courier.*

7. *Terrestrial origin of the alleged Meteoric rain in Hungary.*—In the *Allgemeine Zeitung*, appeared last year a long account of a shower of vast numbers of small meteoric stones, which was asserted to have occurred at Iwan in Hungary, on the night of the 10th of August, 1841. Whether the story is wholly false or not, we are not informed; but an examination of the alleged meteorites, (the results of which appear in *Poggendorff's Annalen*, 1841, No. 11,) shows that the stones are plainly of terrestrial origin. At the request of a society of naturalists in Vienna, Count Paul Szechenyi procured from his estate of Iwan, where this rain is said to have fallen, a mass of earth of a cubic foot in dimensions, dug from a field, which had been three years in clover. This earth, which consisted of a very hard adhesive clay, was subjected to an examination, which resulted in the conviction, that the supposed meteoric hail was only small grains of pisiform iron ore, (bog ore or Limonite,) which were found to be distributed throughout the mass, to a depth of at least twelve inches from the surface, whereas the meteoric stones in question were said to have penetrated the soil only to the depth of half an inch.

8. *Meteorology.*—To the following important notice we invite the particular attention of our readers, with the hope that it will command due attention. Prof. Espy has issued a "circular," which we have received, requesting all persons who keep or are disposed to keep journals of the weather in the United States, Canada, Bermuda, and the West Indies, to signify to him at Washington City, their willingness to furnish him with a copy of them monthly, and if they request it, blank forms will be sent them, with instructions how to observe. Mr. Espy is desirous of obtaining a journal of the weather for the evening and night of the 3d of September, 1821, in the N. W. corner of Connecticut, or S. W. corner of Massachusetts.

Direct—Surgeon General's Office, care of J. P. Espy, Washington, D. C.

9. *Solar Eclipse of July 8th*, 1842.—We have been indulged with the perusal of a private letter from that excellent astronomer, Francis Baily, Esq., giving an account of this superb phenomenon as witnessed by himself at *Pavia* in Italy, over which town the line of central dark-

ness exactly passed. The appearances were every way extraordinary, unexpected, and most singular. At the moment when the total obscuration commenced, a brilliant crown of glory encircled the moon, like the *aureola*, which Catholic painters append to their saints. Suddenly, from the border of the black and laboring moon, thus singularly enshrined, burst forth at three distinct points, within the aureola, purple or lilac flames, visible to every eye. At this moment, from the whole assembled population of the town, a simultaneous and deafening shout broke forth. A similar manifestation of popular feeling occurred at Milan, occasioned by the self-same astonishing spectacle, accompanied in the latter instance with a general *Huzzah! vivent les astronomes!* The eclipse was also viewed from the Superga, near Turin, by our Astronomer Royal, Mr. Airy, apparently under less favorable circumstances.—*London Athenæum.*

10. *Vegetable and Animal Fibrine, Albumen, and Caseine.*—MM. Scherer and Jones, operating in the laboratory of M. Liebig at Giessen, have found that vegetables contain three azotized bodies, which they have called vegetable fibrine, vegetable albumen, and vegetable caseine. These substances possess precisely the same elementary composition. Vegetable fibrine is the matter which does not dissolve when gluten is treated with alcohol—that portion soluble in this liquid they have named vegetable gluten. Vegetable albumen is found in the juice of vegetables, and caseine is extracted from peas, beans, or lentils—when these are treated with water, the portion dissolved is caseine. On comparing the properties of these three bodies with those of the corresponding bodies of animal origin, that is to say, albumen, fibrine, and caseine, it is found that the vegetable substances possess all the properties which belong to those of animal origin, and analysis shows they are isomeric. These unexpected results throw great light on physiological phenomena; they explain the reciprocal transformations which fibrine, caseine, and albumen undergo in the animal organization; they also lead to this very remarkable physiological consequence, that herbivorous animals find in vegetables, substances which are analogous to their blood and muscular fibre. The following are the results of their different analyses:

	Veg. Fibrine.	An. Fibrine.		Veg. Albumen.	An. Albumen.		Veg. Caseine.	An. Caseine.
C.	53.83	54.454	C.	54.74	55.097	C.	54.138	54.507
N.	15.59	15.762	N.	15.85	15.920	N.	15.672	15.670
H.	7.02	7.069	H.	7.77	7.073	H.	7.156	6.900
O. S. Ph.	23.56	22.715	O. S. Ph.	21.64	22.007	O. S. Ph.	23.034	22.923
	100.	100.		100.	100.097		100.	100.

Jour. de Pharm. Jan. 1842. *Lon. Ed. and Dub. Jour. No.* 129, *Feb.* 1842.

Dumas, in his lecture on "the chemical statics of organized beings," remarks on azote:—"This azote, fixed by plants, seems therefore to produce a concrete fibrinous substance, which constitutes the rudiment of all the organs of the vegetable. It also serves to produce the liquid albumen which the coagulable juices of all plants contain, and the caseine so often confounded with albumen, but so easy to recognize in many plants. Fibrine, albumen, and caseine, exist then in plants. These three products, identical in their composition, as M. Vogel has long since proved, offer a singular analogy with the ligneous matter, the amidon and the dextrine.

"Indeed, fibrine is like ligneous matter, insoluble—albumen, like starch, coagulates by heat—caseine, like dextrine, is soluble. These azotized matters moreover are neutral, as well as the three parallel non-azotized matters; and we shall see that by their abundance in the animal kingdom, they act the same part that these latter exhibited to us in the vegetable kingdom. Besides, in like manner, as it suffices for the formation of non-azotized neutral matters, to unite carbon with water or with its elements, so also for the formation of these azotized neutral matters, it suffices to unite carbon and ammonium with the elements of water—48 molecules of carbon, 6 of ammonium, and 17 of water, constitute or may constitute, fibrine, albumen, and caseine.

"Thus in both cases, reduced bodies, carbon or ammonium and water, suffice for the formation of the matters which we are considering, and their production enters quite naturally into the circle of reactions, which vegetable nature seems especially adapted to produce. The function of azote in plants is therefore worthy of the most serious attention, since it is this which serves to form the fibrine, which is found as the rudiment in all the organs—since it is this which serves for the production of the albumen and caseine, so largely diffused in so many plants, and which animals assimilate or modify according to the exigencies of their own nature.

"It is in plants then that the true laboratory of organic chemistry resides; thus carbon, hydrogen, ammonium and water are the principles which plants elaborate: ligneous matter, starch, gums, and sugar, on the one part—fibrine, albumen, caseine, and gluten, on the other, are then the fundamental products of the two kingdoms; products formed in plants, and in plants alone, and transferred by digestion into animals."—*Lond. Edin. and Dub. Jour. No.* 126, *Dec.* 1841.

11. *Oil of Indian corn.**—This oil is obtained in the course of the process of making whiskey. It rises in the mash-tubs and is found in

* We are indebted to our friend Chas. Tracy, Esq., of Utica, for the communication of this notice.—Eds.

the scum at the surface, being separated either by the fermentation or the action of heat. It is then skimmed off, and put away in a cask to deposit its impurities; after which it is drawn off in a pure state, fit for immediate use. The oil is limpid, has a slight tinge of the yellow color of the corn, and is inoffensive to the taste and smell. It is not a drying oil, and therefore cannot be used for paint, but burns freely in lamps, and is useful for oiling machinery.

Both rye and Indian corn are used for distilling, sometimes separate, but often mixed together. When rye is worked, either alone or mixed with corn, no oil is produced; and as the use of corn alone has been commonly supposed to be less profitable for whiskey-making, the existence of corn oil in the froth of the mash-tubs seems not to have been generally known among distillers, until within a few years past. It is now ascertained that by working Indian corn alone, and using a somewhat higher heat than is common, oil may be produced at the rate of one pint for every bushel of corn; and that too without diminishing the quantity of alcohol or impeding its manufacture. The oil sells for one dollar a gallon. The pint of oil therefore repays one fourth of the first cost of the bushel of grain which produces it.

12. *Gold Medal of the Geographical Society, awarded to Prof. Robinson.*—It must be gratifying to all who love the reputation of American science, to learn, that the Royal Geographical Society of London, have recently awarded their gold medal to our distinguished countryman, Prof. Robinson, as a proof of the high estimation in which they held his work, entitled, "Biblical Researches in Palestine, Mount Sinai, and Arabia Petræa." The medal was received by the American minister at London, Hon. Edward Everett, who was addressed on the occasion by W. R. Hamilton, Esq., president of the society, in a pertinent speech, giving a condensed view of the labors of Prof. Robinson. Mr. Everett, on behalf of Prof. Robinson, made a forcible and eloquent reply.

13. *Discovery of a new Metal.*—"In Part VII of my Journal, which you will receive next week, you will find a notice of the discovery of a new metal; it has been named *Didym;* it always accompanies Lanthanium, from which unfortunately it has not yet been separated. All the researches on Lanthanium, as well as those on Cerium, are erroneous."—*Extract of a letter from M. Poggendorff to W. Francis, in the L. E. and D. Phil. Mag. for September.*

Death of Prof. JOHN P. EMMET, *of the University of Virginia.*—We regret that an obituary notice of this eminent individual, which we had expected, was not received in time for this number.

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ACKNOWLEDGMENTS TO CORRESPONDENTS, FRIENDS AND STRANGERS.

Remarks.—This method of acknowledgment has been adopted, because it is not always practicable to write letters, where they might be reasonably expected; and still more difficult is it to prepare and insert in this Journal, notices of all the books, pamphlets, &c., which are kindly presented, even in cases, where such notices, critical or commendatory, would be appropriate; for it is often equally impossible to command the time requisite to frame them, or even to read the works; still, judicious remarks, from other hands, would usually find both acceptance and insertion.

In public, it is rarely proper to advert to personal concerns; to excuse, for instance, any apparent neglect of courtesy, by pleading the unintermitting pressure of labor, and the numerous calls of our fellow-men for information, advice, or assistance, in lines of duty, with which they presume us to be acquainted.

The apology, implied in this remark, is drawn from us, that we may not seem inattentive to the civilities of many respectable persons, authors, editors, publishers, and others, both at home and abroad. It is still our endeavor to reply to all letters which appear to require an answer; although, as a substitute, many acknowledgments are made in these pages, which may sometimes be, in part, retrospective.—*Eds.*

SCIENCE.—FOREIGN.

Address at the anniversary meeting of the Royal Geographical Society, May 24, 1841; by George B. Greenough, President. Forwarded by J. Vaughan.

Fourth Report on the Geological Survey of the province of New Brunswick; by Abraham Gesner, F. G. S. St. John, 1842. pp. 101. From the Author.

An account of experiments made with the view of ascertaining the possibility of obtaining a spark before the circuit of the voltaic battery is completed; by John P. Gassiot, Esq. From the Philosophical Transactions, Part 1st, 1840. London. 4to. pamphlet. pp. 10. From the Author. Received April 16, 1842.

Bulletin de l'Academie Royale des Sciences et Belles Lettres de Bruxelles, année 1841. Tome Huitieme, 1re partie. 8vo. pp. 503. Bruxelles, 1841. From M. Quetelet.

Bulletin de l'Academie Royale de Bruxelles de la Seance du 7 Aout, 1841. No. 8, tome viii. 8vo. pp. 106. Bruxelles, 1841. From M. Quetelet.

Bulletin de la Societé Geologique de France. Tome Onzieme. Paris, 1839–40. 8vo. pp. 513. From the Society.

Nouveaux Memoires de l'Academie Royale des Sciences et Belles Lettres de Bruxelles. Tome 14, 1841. 4to. From M. Quetelet.

Trois Memoires, par et de M. Morin, Ingénieur des Ponts et Chausées, sur ces questions. "Quelle est la nature de la matiére etherée ou repulsive remplissant l'univers? &c." "Peut-on arriver à prevoir le temps, an moins un an a l'avance? &c." "Ne faut il pas rejeter en geologie le système des soulèvemens, et n'est il pas plus probable que les divers terrains se sont formés à mesure que la hauteur de la mer diminnait par le refroidassement du globe?" Paris, 1841.

Etwas über die Natur-Wunder in Nord America, zusammentragen von Charles Cramer. Zweiter abschnite. St. Petersburgh, 1840. pp. 90, 8vo. pamph. Also 1837, pp. 40. From the Author.

Arsberättelse om Technologiens framsteg till Kongl. Vetenskaps Academien afgifen den 31 Mars, 1839; af G. E. Pasch. Stockholm, 1840. pp. 76.

Kongl. Vetenskaps Academiens Andlingar. För Ar 1839. Stockholm, 1839. Received March 10, 1842.

Tal af Academiens Præses Grefve M. Rosenblad. Stockholm, 1840.

Nouveaux memoires de l'Academie Royale des sciences et des belles lettres de Bruxelles. Tome xiii. Bruxelles, 1841. De l' Academie.

A memoir of the fossil reptiles of the Southeast of England; by Dr. Mantell. Quarto, pp. 27. 1842. From the Author, Clapham Common, London. A copy also for Prof. Hubbard, and one for B. Silliman, Jr.

Monografia del genere Murex ossia numerazione delle principali specie del terreni sopracretacei dell' Italia per Giovanni Michelloti. Vicenza, 1841.

Brevi Cenni sullo studio della zoologia fossile per l'Auv. G. Michelloti. Torino, 1841. From the Author. Forwarded by Dr. Mantell, London.

Resumé des observations sur la Meteorologie, par le directeur, A. Quetelet. Extrait du tome xiv, des Memoires de l'Academie Royale de Bruxelles, 1841. From the Author.

Transactions of the Royal Society of Edinburgh, Vol. xiv, part I. Quarto, pp. 348. Edinburgh, 1839. From the Society.

Transactions of the Manchester Geological Society, Vol. I. London, 1841. pp. 236, 8vo. From the Council of the Society.

Report of the eleventh meeting of the British Association for the Advancement of Science, held at Plymouth, July, 1841. From

the Association. pp. 480, 8vo. Another copy from an unknown hand.

Annuaire de l'Academie Royale des Sciences et Belles Lettres de Bruxelles. Septieme année. Bruxelles, 1841. From M. Quetelet.

Practical Geology and Mineralogy; by Joshua Trimmer, F. G. S. American edition. Lea & Blanchard, Philadelphia. pp. 530, large octavo. From the publishers.

Academie Royale de Bruxelles. Bulletin de la Séance du 7 Octobre, 1840, No. 9; du 7 Nov. 1840, No. 10; du 5 Dec. No. 11; du 15 et du 16, Dec. 1841. Bruxelles. De l'Academie.

Address delivered at the anniversary meeting of the Geological Society of London on the 18th of February, 1842; by Roderick Impey Murchison, F. R. S., President. London, 1842. From the Author. Several copies addressed.

A Review of Berkeley's Theory of Vision; by Samuel Bailey. London, James Ridgway, 1842. pp. 238, 8vo. From the Author.

A geological map of Europe. From Wm. C. Woodbridge.

SCIENCE.—DOMESTIC.

Lectures on Agricultural Chemistry and Geology; by Jas. F. W. Johnston, A. M. Published by Wiley & Putnam, New York, 1840. pp. 300, 8vo. From the publishers. 2 copies.

Medical Examiner, New Series. No. 1, Vol. I. Phil. 1842.

Description of an entire head and various other bones of the Mastodon; by Wm. E. Horner, M. D. and Isaac Hayes, M. D. Oct. 2, 1840. 4to. pamph. From the Authors.

The Electrotype; by Prof. John Johnson. pp. 7. From the Author.

Remarks on the treatment of curvature of the spine; by John H. Griscom, M. D. of New York, (from the Am. Journ. Med. Sciences for Jan. 1842.) Phil. From the Author.

A brief description of the Agaricus atramentarius; by John R. Coxe, M. D. Phil. 1842. pp. 12, 8vo. pamph. From the Author.

Remarks upon the coral formation in the Pacific; by Joseph P. Couthouy, (from Journal of Boston Soc. Nat. Hist. for Jan. 1842.) Boston, 1842. pp. 68, 8vo. pamph. From the Author.

Niagara Falls, their physical changes, and the geology and topography of the surrounding country; by James Hall, state geologist of New York, (from the Bost. Journ. Nat. Hist.) pp. 30. From the Author.

Constitution and By-Laws of the Massachusetts Horticultural Society, with a report of its transactions for 1839–41. Boston, 1842. pp. 100.

Transactions of the New Haven Horticultural and the New Haven County Agricultural Societies, 1841. 3 copies.

A Muck Manual for Farmers; by Samuel L. Dana. D. Bixby, Lowell, 1842. pp. 250, small 8vo. From the publisher.

Materia Medica; by Martyn Paine, M. D. New York, 1842. pp. 270, 8vo.

Zoological Contributions; by S. S. Haldeman. No 1, Feb. 1842. Philadel. 6 copies from the Author.

Memoir of the Geological Survey of the State of Delaware; by James C. Booth, A. M. Dover, 1841. pp. 180, 8vo. 2 copies. From the Author.

Transactions of the American Philosophical Society, held at Philadelphia for promoting useful knowledge. 1841. pp. 160, 4to. From the Society.

The Magnet; by Le Roy Sunderland. New York, 1842. Vol. I, No. 1. From Wesley Whitcomb, Esq.

Quarterly Summary of the Transactions of the College of Physicians of Philadelphia. February, March, April, 1842.

University of New York. Medical department—concluding lecture on heat; by Prof. Draper. June 2, 1842. From the Author, through Dr. Goode.

Proceedings of the President and Fellows of the Connecticut Medical Society in convention, May, 1842. Hartford.

Agriculture of Massachusetts, Fourth Report, embracing the counties of Franklin and Middlesex; by Henry Colman, agricultural commissioner. Dutton & Wentworth, Boston, 1841. pp. 528, 8vo. From the Author. Another copy from Sam'l Walley, Jr. Esq.

A popular treatise on Agricultural Chemistry, for the use of the farmer; by Charles Squary, chemist. Lea & Blanchard. Philad. 1842. pp. 154, 12mo. From the publishers.

A popular treatise on Vegetable Physiology, (published under the auspices of the Society for the Promotion of Popular Instruction.) Lea & Blanchard, Philad. 1842. pp. 301, 12mo.

Report on the Insects of Massachusetts injurious to Vegetation, published agreeably to an order of the Legislature; by Thaddeus Wm. Harris. Cambridge, 1841. Folsom, Wells & Thurston. pp. 459, 8vo. From Samuel H. Walley, Jr. Esq.

Bulletin of the Proceedings of the National Institution for the Promotion of Science, 1841.

Second Bulletin of the Proceedings of the National Institution for the Promotion of Science, Washington, D. C. March, 1841, to Feb. 1842. pp. 220, 8vo. From Hon. S. J. Andrews. Received June 24, 1842.

A description of Hydraulic and other Machines for raising Water, &c. &c.; by Thomas Ewbank. New York, D. Appleton & Co. pp. 582, 8vo. From the Author.

A Plea for a National Museum and Botanic Garden, to be founded on the Smithsonian Institution at the city of Washington, by Wm. Darlington, M. D., Dec. 3d, 1841. West Chester, Penn.

MISCELLANEOUS.—FOREIGN.

The Canton Register—a series for 1835. From Rev. Mr. Williams, Macao. Received Jan. 13, 1842.

Wiley & Putnam's Literary News Letters—a series.

La Gacetta Mercantil. Beuenos Aires. Martis 24th de Agosto, 1841. From Capt. Ogden.

The Christian World, London. Vol. II, No. 5. Wiley & Putnam, Paternoster Row.

MISCELLANEOUS.—DOMESTIC.

An Address delivered before the Literary Societies of Marshall College, by John Frost. Philadelphia: pam. pp. 22. Sept. 28th, 1841. From the Gœthean Literary Society.

Second Advent Witness. Henry Jones, editor. New York, Dec. 1841.

Biblical Repertory and Princeton Review, Oct. 1841. Philadelphia.

Constitution and Bye-Laws of the Washington Temperance Society, of the city of New Haven.

Catalogue of the Officers and Students of Washington College, Hartford, 1841–42. From Prof. J. Brocklesby.

The Difficulties of Medical Science, an Introductory Lecture, by R. M. Bird, M. D., Prof. in Penn. Medical College, 1841.

An Essay on the Fast days and Feast days in the Christian Church, containing a review of Bishop Doane's pamphlet, by a Presbyterian. Burlington, 1841.

The Fifteenth Report of the Am. Home Miss. Society, 1841.

The Sixteenth Annual Report of the Prison Discipline Society. Boston, 1841.

Map of the Gulf of Mexico, with a Sketch of Texas. From and by Stuart H. Perry.

Fourteenth Annual Fair of the American Institute. Oct. 1841.

The United States Literary Advertiser. From Lockwood & Smith. N. Y., January, 1842.

A Christmas Gift to the Young Agriculturists of the United States, by John S. Skinner. Washington, 1841.

Message of the President U. S. to both Houses Congress, Dec. 7th, 1841. From J. Trumbull, M. C. Do. from S. J. Andrews, M. C.

Extract from Speech of Mr. Merriwether, Geo., in the House of Representatives of the U. S., Dec. 1841, in reply to the charge of extravagant expenditures of the public money by the Whig party.

Public Documents. From Wm. H. Washington, M. C. The Report from the Commissioner of Patents, showing the operations of the Patent Office for 1841.

Report by Mr. Saltonstall on Tariff, March, 1842. From S. J. Andrews, M. C.

Proceedings of the Congressional Total Abstinence Society, Feb. 25th, 1842. From T. H. Williams, M. C.

Speech of Mr. Huntington of Conn., upon the Resolutions of Mr. Clay, delivered in the Senate of the United States, March 21, 1842. From J. W. Huntington, M. C. Three copies more from various friends.

Report of the Operations of the Patent Office for the year 1841. From H. W. Ellsworth.

Mode of Manufacturing Sugar from the corn stalk, and of oil and stearine from lard. 1842. From H. W. Ellsworth.

Speech of Mr. Slade of Vermont, in favor of a Protecting Tariff, Dec. 20th, 1841.

Plan of Finance, (to accompany bill H. R. No. 206,) Feb. 17th, 1842, made by Mr. Cushing.

Sermon on the Death of the Rev. Jasper Adams, D. D., delivered at Pendleton, by the Rector of Christ Church, Greenville. 1842.

A Lecture by the Rev. H. O. Sheldon, at the Medical College, New York, on the Lyceum system of education, with some account of the first Lyceum village, founded by J. Holbrook. Esq., at Berea, Ohio. June, 1841.

The Self Instructor, J. Holbrook, Esq., Editor. March, 1842. Vol. I, No. 3.

Catalogue of Washington College, Lexington, Va. 1842.

Letters on Elementary and Practical Education, by Charles Mondelet, Esq. Montreal, 1841. From the Anthor.

Circular and Catalogue of Willougbby University, 1841–42. Cleveland.

" The end of the World not yet." A Discourse delivered in the North Church, Newburyport, on the last evening of the year 1841, by Rev. L. F. Dimmick. From Charles Whipple, Esq.

The American Tract Magazine, March 14th, 1842, Vol. XVII, No. 3. New York.

Annual Report of the Board of Trustees of the Massachusetts General Hospital for the year 1841. Boston, 1842.

Ninth Annual Report of the Trustees of the State Lunatic Hospital at Worcester, Dec. 1841. pp. 100. From Dr. Woodward.

Introductory Address delivered at the Organization of Bethany College, Nov. 2d, 1841, by Prof. Richardson. Bethany, Va.

Proceedings of the American Board of Commissioners for Foreign Missions, at the special meeting in New York, Jan. 18th, 19th, and 20th, 1842.

Report of the Committee of the Home League, and the Tariff laws and their effects. New York, Feb. 1842.

Quarterly Summary of the Transactions of the College of Physicians of Philadelphia, Nov. and Dec. 1841, and Jan. 1842.

Charter of the Mutual Security Insurance Company of New Haven, chartered by the Legislature of the State of Conn., May, 1841. New Haven, 1842.

Catalogue of Fruit and Forest Trees in the Garden and Nursery of Parsons & Co., Flushing, L. I. 1842.

Twenty-fifth Annual Report of the American Colonization Society. Washington, 1842. Two copies.

Catalogue of the University of the State of Alabama, 1842.

Dr. Paine's Answer to the Circular Letters by Drs. Carpenter and Forbes. Boston, 1842.

The Memorial in relation to the Promotion and Protection of National Industry; adopted by a meeting of citizens held in the College Hall, Cincinnati, 1842. From N. Guildford.

Twenty-third Annual Report of the Directors of the New York Institution for the Deaf and Dumb. 1842.

The American Magazine, edited by Messrs John S. and B. Wood. Boston, Albany and New York. Vol. II, No. 1, Jan. 1842. From the Editors.

American Jurist and Law Magazine, edited by L. S. Cushing and S. F. Dixon. No. 52, Jan. 1842. Boston.

Booksellers' Catalogues, from Wiley & Putnam and J. M. Mason, New York; also Little & Brown, Boston, and A. H. Maltby, New Haven.

Review of Webster on Orthography, by A. B. Chapin.

Report of a Committee appointed by the Trustees of the town of Milwaukie, relative to the commerce of that town, and the navigation of Lake Michigan. Milwaukie, W. T. 1842. From J. A. Lapham.

Public Documents. From J. H. Brockway, M. C. Report on the Colonial Trade with Great Britain, April 14th, 1842; also Report of Mr. Saltonstall on Tariff, March 31st, 1841. Revised Tariff Report of the Secretary of the Treasury.

Longitude of the Capitol. Report made by Wm. W. Boardman, M. C. From Mr. Boardman.

Mr. Adams' Speech on War with Great Britain and Mexico, with the Speeches of Messrs. Wise and Ingersoll, to which it is in reply. From J. Trumbull, M. C.

Speech of Mr. Campbell of South Carolina, on the General Appropriation Bill, April, 1842. From the Author.

Report of the Secretary of the Treasury on Revised Tariff. From J. L. Andrews.

Mr. Cushing's Report on the Colonial Trade, Great Britain.

Report upon the Standards of the liquid capacity measures of the system of uniform standards for the United States, by F. R. Hassler. 1842. Washington.

"An Humble Tribute to my Country," or Practical Essays, by Samuel Elliot. Boston, 1842. Small 12mo, pp. 240. From the Author.

Medical Intelligencer and Quarterly Advertiser. Phil., May, 1842. No. 1.

A Sketch of the Philosophy of Government, by W. D. Mevey, Lewiston.

Fourth Annual Report of the Board of Commissioners of Common Schools in Connecticut. Hartford, 1842. From H. Barnard, Esq.

The Annual Report of the Trustees of the Perkins Institution for the Blind, 1842. Boston. Two copies.

An Account of the Visit of the French Frigate l'Artemise to the Sandwich Islands, July, 1839. Honolulu. A Sermon preached at Honolulu, March 6th, 1841, at the funeral of Angeline, wife of S. N. Castle, assistant missionary. From Mr. Castle.

Obituary Notice of Mrs. Angeline L. Castle, by Rev. R. Armstrong.

Report of the Select Committee on the Geological Survey in the New York Assembly, 1840. From Mr. Hall.

Temperance Speeches, by Hon. T. F. Marshall, Kentucky.

The Ambassador. New York. Vol. I, No. 1. Two copies. From Dr. Brigham.

Catalogue of English Books for sale by D. Appleton & Co. N. Y.

Review of Dr. Sprague's Sermon on the danger of being over wise. Boston, 1842. pp. 88, 12mo. pamph.

Light House at Flynn's Knoll, N. Y. U. S. Rep. Doc. No. 746. From Hon. Mr. Brockway.

NEWSPAPERS.—DOMESTIC.

Daily National Intelligencer, Washington, Thursday, Jan. 20th, 1842. From J. W. Bruen, with a notice of this Journal.—New York State Mechanic, Albany, Dec. 18th, 1841, Vol. I. No. 4.—Nashville Union, Dec. 1841, with account of a vacuum engine.—Wilkesbarre Advocate, Jan. 12th, 1842, with an obituary of Samuel Richards, Esq.—Ohio Observer, with meteorological journal for Oct. Nov. Dec. Jan. Feb. and March, kept by Prof. Loomis.—New York Tribune, Jan. 1st, 1842.—The Boonlick Farmer, Dec. 1841, Vol. I, No. 2.—St. Louis New Era. From C. C. Whittlesey, with Mr. Thomas's Report on the armory. Dec. 7th, 1841.—Daily Evening Gazette, St. Louis, Jan. 12th, 1842. From E. A. Thompson.—The Bank Reformer, No. 4, Petersburg, Va.—New Genesee Farmer, Nos. 1 and 2, Rochester, Feb. 1842.—Daily Cincinnati Gazette, Oct. 22d, 1841.—New York American, Jan. 15th, 1841, with a notice of this Journal.—The Independent, Washington City, Feb. 8th, 1842. From J. Trumbull.—Public Ledger, Philad. Feb. 10th, 1842, with a circular.—Do., with a notice of Mr. Lyell's lecture.—Boston Journal, with an advertisement of the

Lowell lectures.—Utica Daily News, from C. E. Lester, editor, with notices of his book.—Vicksburg Daily Whig, with a meteorological table for the year.—Do. from G. W. Niles, New York.—Albany Argus, April 15th, 1842.—Dyot's Oracle of Health, Phil. No. 1, Vol. 1.—The Wampanoag, edited by Francis H. Whipple, Fall River, Mass., April 16th, 1842.—The Morning Chronicle, Pittsburg, March 3d, 1842, with a communication by Prof. Henry on the safety valve.—Chicago Daily American, Dec. 28th, 1842.—N. York Tribune, with Mr. Lyell's first lecture.—Boston Journal, Jan. 27th, 1842, with an account of temperance in the navy.—Weekly National Intelligencer, Washington.—Daily Albany Argus, with the trial of E. C. Delavan.—Troy Daily Whig, Feb. 24th, 1842. From D. L. Harris, with an account of a steam excavating machine.—The Elevator, Cincinnati. From the publishers, J. H. Lovejoy and D. H. Robertson.—A series of the Daily Chronicle, Phil., with reports of Mr. Lyell's lectures in that city. From Mrs. Lyell.—The Frederick Herald, Md., with an account of a ramble among the mountains of Virginia, Sept. 4th, 1841.—New York Sun, with an article on the Exchange Lyceum.—The Sun, extra, Baltimore, March 30th, 1842.—Public Ledger, Phil., with do. to the Chronicle.—Planter's Banner, Attakapas, La., Jan. 1842.—Troy Daily Whig, April 1.—The Topaz, Middlebury, Vt.—Boston Journal, Feb. 1st, with an account of temperance in the navy.—New York Tribune, March 28th.—Daily Chronicle, Cincinnati. From N. J. Williams, with a meteorological table for Feb.—Nashville Union, an article on the steam engine. From and by G. A. Stewart.—The Respondent, Albany, March 1st.—Wayne Co. Herald.—New York Tribune, with a lecture on magnetism, by Richard A. Locke.—Rocking Valley Gazette, Jan. 4th and 28, with a notice of a meteor.—Young Ladies' Casket, Charlestown, Mass.—Quarterly paper of the Foreign Evangelical Society. Two copies.—Do. No. 4.—Boston Times, May 11th, 1842.—Albany Argus, April 15th, 1842, with the controversy between Dr. Sprague and E. C. Delavan, Esq.—Daily National Intelligencer, Washington.—New York Daily Tribune, May 15th.—The News, St. Augustine, Florida, May 9th.—Jackson Phœnix, Jackson, La.—American Millenaria, New York and Boston, May 2d, 1842.—A series of the Wampanoag, Fall River, Mass. From the editors.—Albany Daily Advertiser, April 6th, 1842.—Signal of Liberty, Ann Arbor, May 2d, 1842.—New York Tribune, May 26th, with a notice of sale of minerals.—Dyot's Oracle of Health, Nos. 1, 2, 3, Philadelphia.

NEWSPAPERS.—FOREIGN.

The Scotsman, Edinburgh, Dec. 1st, 1841. From J. Dunlop, Esq.—The Standard, with an account of the extraordinary disturb-

ance of the magnetic instruments at the Royal Observatory, Greenwich. El Comercio, Lima, 11 de Decembre, 1841.—Diario Commercial Politico y Literario, Buenos Aires, Marte 24, 1841.

SPECIMENS.

A few specimens of fossils from the coal strata of Halifax, England. From Mr. Jeremiah Howarth, of England.

A series of coal fossils from Jarrow colliery, Yorkshire, England. From Prof. J. F. W. Johnston, Durham, England.

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The article on Meteoric Iron, by the junior Editor, announced last number, has been postponed to give place to other correspondents.

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ERRATUM.

In Vol. XLII, No. I, in Dr. Hare's Objections to Mr. Redfield's theory, paragraph 1, line 13, for *same*, read *successive*.

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